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Plantability and influence of the application of graphite associated with the chemical treatment of soybean seeds

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ABSTRACT

Brazil stands out among the world's largest soy producers. The uniformity in the deposition of seeds and the correct distribution of plants are important factors for the crop to express its maximum productive potential. The present study aimed to evaluate the influence of the lubricant agent “graphite”, applied during and after the chemical treatment of soybean seeds in function of its longitudinal distribution at different operating speeds. For this purpose, a seeder with mechanical type feeder was used, at three working speeds: 4, 6 and 8 km h^{-1} and conducted in a strip design, organized in a 2x3 factorial scheme, with two different modes of application of graphite and 3 operating speeds. The results presented showed that the addition of graphite concomitantly with the seed treatment, increases the unevenness of sowing, the same occurs in relation to the increase in the speed of operation. Graphite loses lubricating action when added to the seed treatment, increasing the number of failures.

Keywords: Seed distribution, Planting speed, Seed lubricant, Coefficient of variation, Deficient spacing.

Plantabilidade e influência da aplicação do grafite associado ao tratamento químico de sementes de soja

RESUMO

O Brasil destaca-se entre os maiores produtores mundiais de soja, sendo a uniformidade na deposição de sementes e a correta distribuição de plantas, fatores importantes para que a lavoura expresse seu máximo potencial produtivo. O presente trabalho teve como objetivo avaliar a influência do agente lubrificante “grafite”, aplicado durante e após o tratamento químico de sementes de soja em função de sua distribuição longitudinal em diferentes velocidades de operação. Para tanto, foi utilizada uma semeadora com dosador do tipo mecânico, em três velocidades de trabalho: 4, 6 e 8 km h^{-1} e, conduzido em um delineamento em faixas, organizados em esquema fatorial 2x3, sendo dois diferentes modos de aplicação do grafite e 3 velocidades de operação. Os resultados apresentados mostraram que a adição de grafite concomitante ao tratamento de sementes, aumenta a desuniformidade de semeadura, o mesmo ocorre em função da elevação da velocidade de operação. O grafite perde ação lubrificante quando adicionado junto ao tratamento de sementes, aumentando o número de falhas.

Palavras-chave: Distribuição de sementes, Velocidade de plantio, Lubrificante da semente, Coeficiente de variação, Espaçamento falho.

1. Introduction

Soy is one of the main agricultural crops in Brazil, and the cultivated area in the country was 38.3 million hectares in the 2020/2021 harvest, showing a growth of 3.6% compared to the previous harvest (Conab, 2021). However, some obstacles in the agricultural sowing operations of the crop must be overcome, in order to reach new productive levels.

To achieve these new output levels, it is necessary to observe important points, such as the suitable stand and the distribution of plants (Cintra et al., 2020). In this sense, it is observed that the variability of seed deposition is mainly affected by the speed of operation of the mechanized set, sowing depth and seed treatment (Kurachi et al., 1993; Garcia et al., 2011).

Plantability is the term that corresponds to the adequate distribution of seeds along the sowing furrow in terms of ideal density and depth for the establishment of the plant culture (Amado et al., 2005; Bertelli et al., 2007). Stand failures can cause an underutilization of solar radiation, water and nutrients, limiting grain yield (Jasper et al., 2006; Fiss et al., 2018). Aiming at improving plantability, the use of graphite, as a seed lubricant in the metering mechanisms, can result in less mechanical damage.

Soybean cultivation requires prior seed treatment in pre-sowing (Parisi and Medina, 2013). The order of deposition of elements in seed treatment can affect the fluidity of seeds in the feeders, influencing their performance in the field. There are two ways to carry out the seed treatment, the “On Farm” system, known as on-farm treatment, and the industrial seed treatment (TSI), in which the producer receives the seeds previously treated by the processing unit. In addition to the protective treatment with chemical agents such as fungicides and insecticides, farmers use other elements in the seeds, such as fluidity agents, pigments and microorganisms that promote biological nitrogen fixation.

The chemical treatment of seeds can make the seeds coarser, hindering the filling dynamics of the alveolar discs and, consequently, causing damage to the seeds and sowing failures. The problem can be alleviated by adding graphite to the seeds, which reduces friction and improves flowability (Mantovani et al., 1999), as graphite has an inert lubricant character, being widely used in agriculture in recommended doses of 4g of graphite powder for each kg of seeds in the seeder (Goulart, 2000).

This study aimed to evaluate the quality of longitudinal seed deposition, in a seeder equipped with mechanical metering, working at three speeds, with two forms of seed treatment "On Farm", the first with addition of graphite in sequence to chemical treatment, without drying time, and the second with the addition of graphite after the drying of the chemical seed treatment.

2. Material and Methods

The experiment was conducted at the experimental farm Lageado, belonging to the State University of São Paulo, Faculty of Agronomic Sciences (Unesp - Botucatu – SP). The soil was classified as a Typic Hapludox according to Soil Taxonomy (USDA, 2014) or “Latossolo Vermelho Amarelo distrófico típico” according to Brazilian Soil Classification System (Santos et al., 2018), and the experimental plots were conducted under no-tillage system under black oat straw.

A Semeato model PD17R seeder-fertilizer machine with 7 rows spaced 0.45 m apart was used, equipped with mechanical type horizontal disk seed dosers, Titanium model – J. ASSY Agrícola, with 9mm Rampflow technology, with 90 holes and shield ring with 1mm recess (Figure 1).

To pull the seeder during the field tests, a tractor John Deere model 6600 (4x2 TDA) with 121 hp of engine power was used. Seeds of the cultivar TMG Intacta RR IIPRO were used, at a density of 16 seeds per linear meter, targeting a population of 355.000 plants ha^{-1}.

The experimental design was in strips, 50 meters long each, in a 2x3 factorial scheme, consisting of two forms of seed treatment and three sowing operation speeds. Twelve repetitions were performed for each treatment. The speeds used were V1 = 4 km h^{-1}, V2 = 6 km h^{-1} and V3 = 8 km h^{-1}, and the two applied seed treatments were T1: addition of 4g of graphite per kg of seeds, after a time of 20 minutes, necessary for drying the chemical seed treatment; and T2: addition of 4g of graphite per kg of seeds concomitantly with the chemical treatment of the seeds. The chemical treatment used in T1 and T2 consisted of 300 ml of Cruiser 350 FS; 300 ml of Vitavax + Tiram, and 150 ml of Biomax for every 100 kg of seeds.

The response variables obtained in the experiments were, acceptable, double and missing spacing index (%), according to the methodology proposed by Kurachi et al. (1993) (Table 1). The coefficient of variation (CV%) was calculated in the analysis of seeding spacing, as this serves as a parameter indicating the quality and precision of the operation. CV% is a correlation between the average (cm) of the spacings analyzed and their standard deviation obtained through equation 1.

$$CV = (DP/\dot{x}) \times 100 \quad \text{(Equation 1)}$$

On what:
CV = Coefficient of Variation (%).
SD= Standard Deviation.
$\bar{x}$ = Average spacing (cm).

The data obtained underwent the Anderson-Darling normality test, analysis of variance and, when applicable, Tukey test at 5%.

Figure 1. Seeder and dosing mechanisms used in the experiment.

Table 1. Acceptable, double, and fault spacing index (%)

Classification	ESD* Spacings
ceptable	3,1 cm < ESD < 9,4 cm
Fault	ESD > 9,3 cm
Double	ESD < 3,1 cm

* Spacing between deposited seeds

3. Results and Discussion

The results of the test of averages for the fault spacing index are shown in Figure 2. In the T2V3 treatment, the highest rates of faulty spacing were verified. The lowest faulty spacing indexes were obtained with the lowest operating speed (Figure 2). The results found corroborate those obtained by Anghinoni (2019), where the increase in sowing speed provided less normal spacing and faultier spacing, and the lower speeds led to greater regularity.

In global values, the highest indexes of faulty spacing (Figure 2) were obtained at T2, this fact can be explained by the ineffectiveness of graphite as a lubricating agent when applied concomitantly with seed treatment. The application of graphite at the time of chemical treatment reduces the fluidity of the seeds and reduces the lubrication efficiency. The observed results corroborate those obtained by Mantovani (1999), who verified that the chemical treatment of the seeds modifies their surface condition, increasing the roughness and hindering the correct filling of the alveoli in the feeders.

Correia et al. (2020) in an evaluation of different metering mechanisms, stated that, speeds above 4.5 km h^{-1} cause higher failure and double-spacing rates in soybean crops, which contributes to justify the behavior of T1V1 in relation to the double-spacing index, where it was verified 14.74% of double spacing for T1V1, and statistical differentiation in relation to the other treatments. With the increase in the work speed, the peripheral rotation of the disc also increases, causing, in this case, loss of efficiency of the doubles eliminator (scraper), showing the influence of speed in the expression of double spacings (Figure 3).

According to Francisco et al. (2016), in a study evaluating plantability, a correlation was found between the increase in double spacing and sowing speed, fact that was observed in the findings of this study. Schuch et al. (2008), mentions that the occurrence of double seeds is one of the main drawbacks of the sowing operation, as two plants will compete for energy resources throughout the crop cycle, severely reducing their productive potential.

The level of acceptable spacing was higher in T1V1 with 62.9%, in agreement with Mantovani et al. (1999), who obtained better results in planting speed for mechanical feeders in the range of 5 km h^{-1} (Figure 4).

The results obtained for the doubles and failures indices presented in figure 4 are in agreement with those of Correia et al. (2015), where it was found that lower operating speeds favor higher yields, improve agronomic aspects such as the number of pods per plant and the plant stand.

Studies carried out by Correia et al. (2020), consolidate that the operating speed is directly proportional to the planting quality, increasing the number of faulty and double spacings and reducing the acceptable spacing, such information corroborates the results presented in figure 5.

Figure 5 shows that increasing sowing speed provides an increase in failures and doubles, reducing the index of acceptable spacing, a fact that corroborates Silva et al. (2000), where with increasing sowing speed, the number of acceptable spacings decreased, a fact that can be explained by the increase in seed turbulence inside the conductor tube. The highest speed, 8km h^{-1}, caused a decrease of 16% in acceptable spacing in relation to the speed of 4 km h^{-1}.

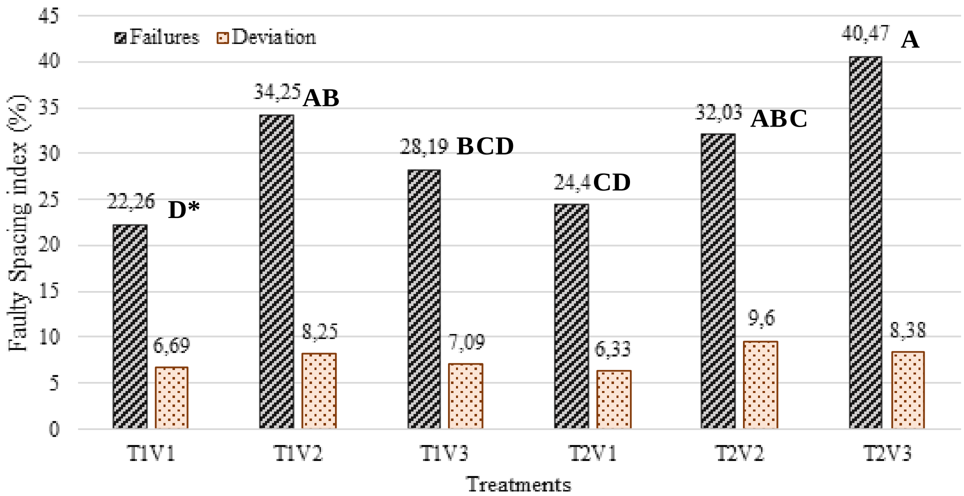

Figure 2. Soybean faulty spacing index as a function of T1 and T2 seed treatments and V1 velocities; V2 and V3 (4; 6 and 8km h^{-1}) with respective standard deviations (SD). *Equal letter averages do not differ statistically between treatments according to the Tukey test at 5% probability. (n=12; F=8.89; p=<0.005).

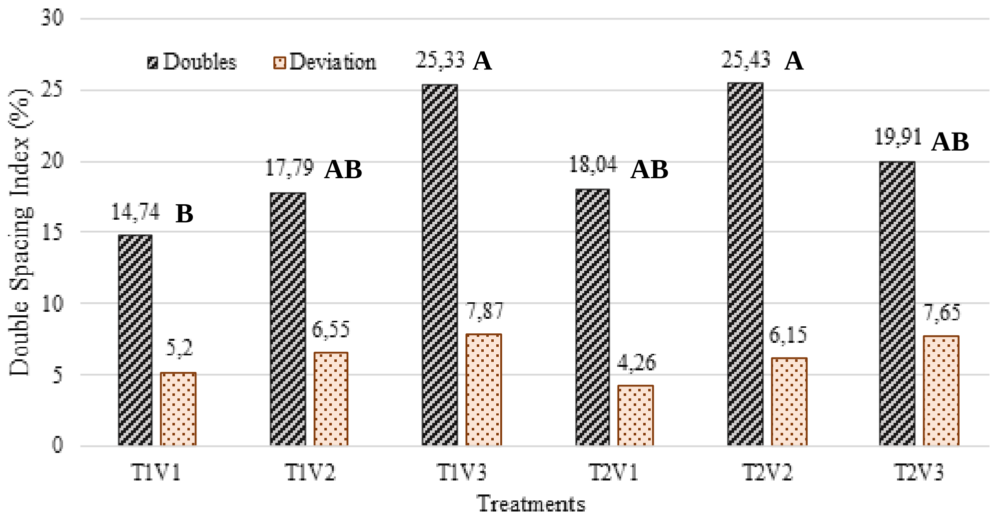

Figure 3. Soybean double spacing index as a function of T1 and T2 seed treatments and V1 velocities; V2 and V3 (4; 6 and 8km h^{-1}) with respective standard deviations (SD). *Equal letter averages do not differ statistically between treatments according to Tukey's test at 5% probability. (n=12; F=8.89; p=0.000).

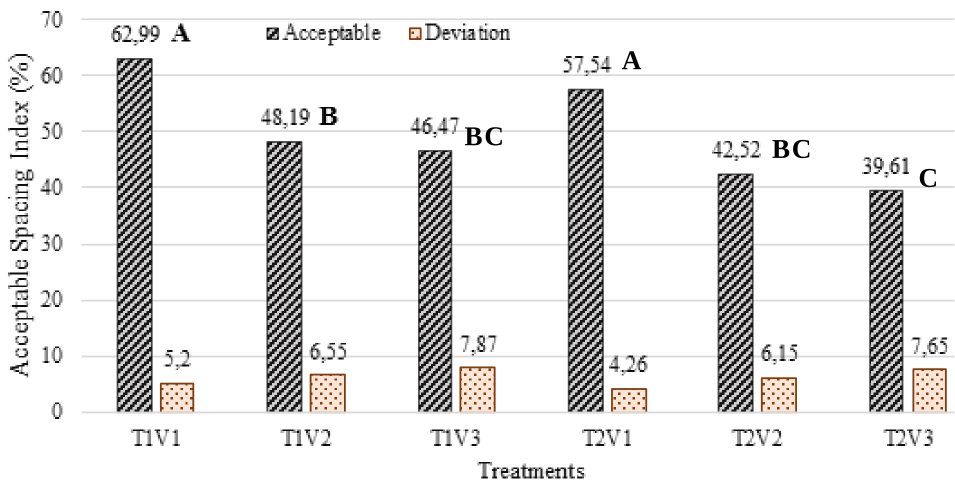

Figure 4. Soybean acceptable spacing index as a function of T1 and T2 seed treatments and V1 speeds; V2 and V3 (4; 6 and 8km h^{-1}) with respective standard deviations (SD). *Equal letter averages do not differ statistically between treatments according to the Tukey test at 5% probability. (n=12; F=8.89; p=0.000)

Acceptable spacings linearly decreased as seeding speed increased, while the regression curve of faulty spacings increased linearly, showing proportionality between the number of failures and the operating speed (Figure 6). In addition, it was shown that when planting speed was increased to 8 km h^{-1}, the spacing between plants increased (Figure 6), a fact that corroborates to

Dias et al. (2009). Failures increased linearly with respect to speed by the addition of graphite along with the treatment. The addition of graphite with the treatment, without the drying time, results in a rough surface on the seed coat after drying, which can make it difficult to accommodate it on the disk ar high speed. Seeds with rough surfaces are harmful to the good performance of the dosing mechanism (Mantovani, 1999). However, Carpes et al. (2018) did not find a negative relationship between the application of graphite and seed treatment, a fact that needs to be better investigated for each seed variety and chemical principle applied.

At the speed of 6 km h^{-1}, there was a greater proportion of double spacing. At speeds over 6 km h^{-1} the double seed index decreased due to the shorter time of seed accommodation in the disc alveolus. At high disc rotation speeds, the seeds do not have enough time to fill all the alveoli of the metering disc, with this there will be distribution failures (Garcia et al., 2011)

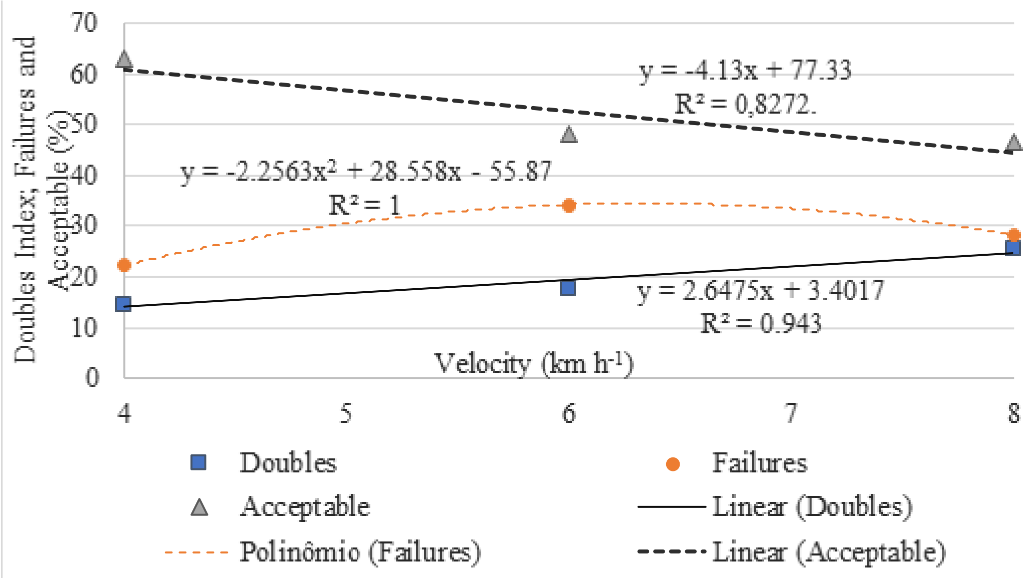

Figure 5. Regression analysis of variables: doubles, failures and acceptable in soybean crop with seed treatment "On farm" in T1 at speeds V1; V2 and V3 (4; 6 and 8 km h^{-1}).

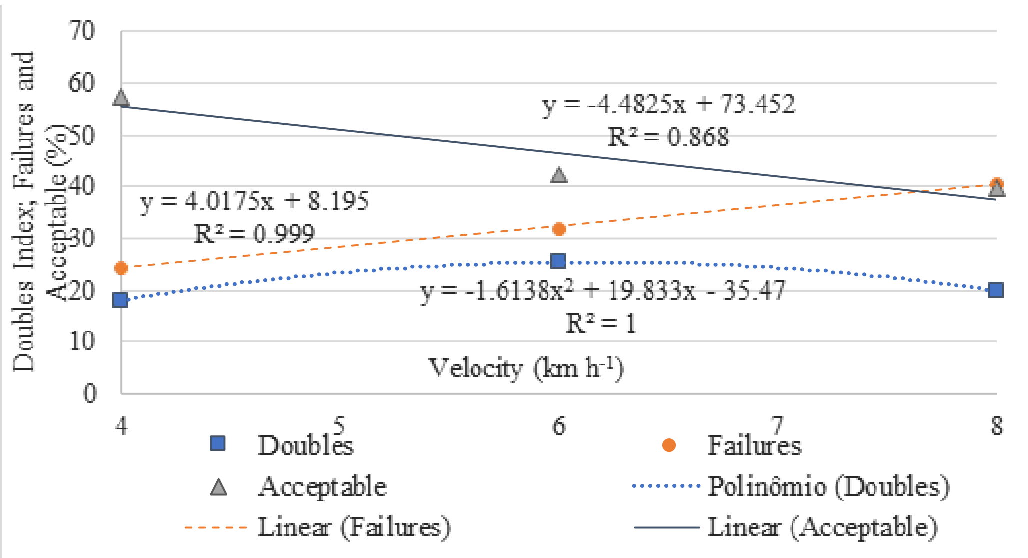

Figure 6. Regression analysis of variables: doubles; failures and acceptable in soybean crop with seed treatment "On farm" in T2 at V1 speeds; V2 and V3 (4; 6 and 8 km h^{-1}).

Conclusions

The increase in sowing speed negatively affects seed distribution quality, increasing the number of failures and doubles in the field.

Graphite, when added to the chemical treatment of seeds, loses its lubricating power and directly affects the efficiency of the operation. The addition of graphite concomitantly to seed treatment and the increase in sowing speed negatively affect the longitudinal distribution of seeds during the sowing operation.

Authors' Contribution

Júlio César Pereira contributed to the setup of experiment, data collection and writing. Aldir Carpes Marques Filho contributed to writing, statistical analysis, and interpretation of results. Flávia Luize Pereira de Souza and Paulo Roberto Arbex Silva contributed to writing and revision of the manuscript.

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