PERFORMANCE OF HORIZONTAL SEED METERING TECHNOLOGIES FOR MAIZE AT DIFFERENT ANGULAR VELOCITIES

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ABSTRACT

Brazil is a global leader in grain production, with an estimated record of 353.1 million tons for the 2025/26 harvest. Maize cultivation showed an increase in the total estimated sown area, totaling 22.7 million hectares across the three harvests, with a 4% growth expectation—rising from 21.7 million hectares in 2024/25 to 22.8 million hectares in the current season, which corresponds to an increase of 871,800 hectares. The demand for maize grain is steadily growing for both animal feed and export. To achieve this significant growth, meticulous attention to sowing is crucial, as several factors influence the success of this operation. Among these, proper seeding is one of the most important. Furthermore, the type of technology used in seeders equipped with horizontal plate meters is fundamental, as it can significantly improve or worsen the seed singulation process within the metering mechanism—a factor that directly impacts seed distribution in the soil, leading to skips, doubles, and even triples, which directly affects crop yield. Considering the importance of these factors and the large number of horizontal plate seed-cum-fertilizer drills still present in Brazil and several other Latin American countries, the agricultural machinery and equipment industries are constantly developing new technologies to improve these conventional metering devices, which still represent a large market share. This study aimed to evaluate the singulation capacity in maize seed metering using a test bench, accounting for the number of seed plate cells classified as skips, doubles, and normals. Three horizontal plate technologies were evaluated: J. Assy® RampFlow technology, Scherer® Blue Fusion tapered-hole technology, and conventional Scherer® technology at three simulated angular velocities (7.1, 9.0, and 10.8 rpm). The J. Assy® RampFlow technology achieved the best results across all rotations, yielding 99.34% normal cells, 0.6248% doubles, and 0.0298% skips. The results for normal and double cells using the J. Assy® RampFlow technology were significant according to the Tukey test at a 5% probability level. This study concluded that the technology integrated into horizontal seed plates directly influences performance in conventional systems utilizing horizontal meters.

Keywords: Plantability; Corn; Horizontal Discs.

RESUMO

O Brasil é líder mundial na produção de grãos, com uma safra recorde estimada em 353,1 milhões de toneladas para o ciclo 2025/26. O cultivo do milho apresentou um aumento na área total semeada, totalizando 22,7 milhões de hectares nas três safras, com uma expectativa de crescimento de 4% — passando de 21,7 milhões de hectares em 2024/25 para 22,8 milhões de hectares na temporada atual, o que corresponde a um incremento de 871.800 hectares. A demanda pelo grão de milho cresce de forma constante, tanto para alimentação animal quanto para exportação. Para atingir esse crescimento significativo, a atenção meticulosa à semeadura é crucial, pois diversos fatores influenciam o sucesso desta operação. Entre eles, a correta deposição de sementes é um dos mais importantes. Além disso, o tipo de tecnologia utilizada em semeadoras equipadas com dosadores de disco horizontal é fundamental, pois pode melhorar ou prejudicar significativamente o processo de singulação no mecanismo dosador — fator que impacta diretamente a distribuição das sementes no solo, ocasionando falhas, duplos e até triplos, o que afeta diretamente o rendimento da cultura. Considerando a importância desses fatores e o grande número de semeadoras-adubadoras de disco horizontal ainda presentes no Brasil e em diversos outros países da América Latina, as indústrias de máquinas e equipamentos agrícolas desenvolvem constantemente novas tecnologias para aprimorar esses dispositivos convencionais de dosagem, que ainda representam uma grande fatia do mercado. Este estudo teve como objetivo avaliar a capacidade de singulação na dosagem de sementes de milho utilizando uma bancada de ensaios, contabilizando o número de alvéolos dos discos classificados como falhas, duplos e normais (aceitáveis). Três tecnologias de discos horizontais foram avaliadas: tecnologia J. Assy® RampFlow, tecnologia de furos cônicos Scherer® Blue Fusion e a tecnologia convencional Scherer®, em três velocidades angulares simuladas (7,1; 9,0 e 10,8 rpm). A tecnologia J. Assy® RampFlow obteve os melhores resultados em todas as rotações, alcançando 99,34% de alvéolos normais, 0,6248% de duplos e 0,0298% de falhas. Os resultados para alvéolos normais e duplos utilizando a tecnologia J. Assy® RampFlow foram significativos de acordo com o teste de Tukey ao nível de 5% de probabilidade. Este estudo concluiu que a tecnologia integrada aos discos horizontais influencia diretamente o desempenho em sistemas convencionais que utilizam dosadores horizontais.

Palavras Chaves: Plantabilidade; Milho; Discos Horizontais.

INTRODUCTIONS

The cultivation of maize (*Zea mays L.*) has advanced significantly in global agriculture. Brazil follows this trend, with the 2025/26 harvest estimated to reach new grain production records. Maize production, in particular, is expected to see a 4% growth in the total sown area.

Cultivated worldwide, maize has historically represented one of the cornerstones of Brazilian agriculture, serving both human and animal nutrition. A member of the Poaceae family, this grass species likely originated in Mexico, later spreading to the United States and the Antilles. In Brazil, its cultivation was initiated by indigenous populations prior to Portuguese arrival, though production and consumption increased substantially with early colonial diets (MEDINA, 2020).

Brazil possesses immense potential for maize cultivation, primarily due to favorable agro-climatic zoning across most of its territory. This allows some states to achieve up to a third harvest. However, the country’s greatest potential lies in the second crop, known as the "safrinha," which is sown after the soybean harvest. This season accounts for the majority of Brazilian maize production and is concentrated mainly in the Central-West region (CONAB, 2022).

To achieve high yields, a critical factor is the correct establishment and management of the plant stand. This process begins with the precise distribution of seeds within the sowing row, avoiding

gaps (misses), doubles, and dominated plants. These spatial irregularities often arise from excessive planting speeds, incorrect adjustments of the metering disks, or uneven seedling emergence. Specifically, plants that emerge later than their neighbors due to varying seeding depths exhibit lower productive potential compared to those that emerge early.

Among current yield-limiting factors in maize, the choice of seed metering technologies and planting disks has become a decisive factor for plantability. Given the diverse technologies available on the market, understanding their individual performance is essential for the crop to express its full genetic potential.

Therefore, this study aimed to evaluate the singulation capacity in maize seed metering using a test stand at three angular disk rotation speeds and three different disk technologies. The performance was quantified by classifying cells as missed, multiple (doubles), or normal (singulated).

MATERIAL AND METHODS

This study was conducted at the After-Sales Laboratory of the J. Assy manufacturing unit, located in Caldas Novas, Goiás, Brazil (Latitude 17°43'32" S; Longitude 48°37'19" W; Altitude: 723.37 m).

The experiment evaluated three horizontal seed disk technologies (Figure 1): the RampFlow technology by J. Assy®, the Blue Fusion tapered-hole technology by Scherer®, and the conventional technology by Socidisco®. These were tested under three simulated angular speeds (7.1, 9.0, and 10.8 rpm) with four replications, arranged in a 3x3x4 factorial design, totaling 36 experimental evaluations.
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Figure 1. 1-A: J. Assy® disk with RampFlow technology; **1-B:** Scherer® disk with tapered-hole technology; **1-C:** Conventional Socidisco® disk.

A **B** **C**

Source: Author's archive.

To simulate the peripheral speeds, a static test stand was utilized, equipped with a GSA gear motor (0.33 hp, 70 rpm Weg Cestari Geremia Three-phase G101E) and a cast iron adapter base for a conventional mechanical seed meter. The system included a Curtis controller to monitor the number of disk cells (holes) scanned, a master switch for system operation, and a conventional mechanical meter with a transmission box and a knockout sprocket (rosette) for 28-hole disks (Figure 2).

Figure 2. Static test stand.

Source: Author's archive.

All three disks featured a 13 mm hole diameter, 28 holes, and were paired with 2.5 mm recessed rings—the ideal disk and ring configuration for the Dekalb maize seed size (sieve) selected for this experiment. It is noteworthy that the seeds were classified as round.

For each combination of planting disk and speed, 560 cells were evaluated across four replications. This process determined the singulation indices, categorized as: normal (cells containing a single seed), misses (empty cells), and multiples/doubles (cells containing more than one seed). The counting of missed, double, and filled holes was performed using a four-digit manual tally counter (Western), with two operators recording the occurrences of doubles and misses in real-time during the tests.

The experiment was conducted in a Completely Randomized Design (CRD) under a factorial scheme, involving three types of metering disks and three speed levels (Table 1). Data normality was assessed using the Shapiro-Wilk test. Data meeting the assumptions for analysis of variance (ANOVA) were subjected to Tukey's test at a 5% significance level for multiple comparisons of means.

For data that did not meet the normality assumptions, a power transformation (squaring the values) was applied to achieve a normal distribution. Subsequently, the transformed data were subjected to ANOVA and mean comparisons using Tukey's test. All statistical analyses were performed using the R environment for statistical computing (R Core Team, 2024).

RESULTS AND DISCUSSION

There was no significant interaction between the disk type and speed factors for any of the variables analyzed during the bench tests (Table 2). This lack of interaction between treatments may be attributed to the use of a static test stand, which does not account for the effects of soil-induced vibration on the metering disks, as well as the operation at relatively low angular speeds (7.1, 9.0, and 10.8 rpm).

Lopes (2018), when comparing different metering mechanisms for the variable "number of misses," observed no significant difference at a speed of 4 km h^{-1}. In contrast, Alonço et al. (2024), evaluating the performance of horizontal plate meters in maize seed distribution as a function of disk rotation variations (17.14, 20.00, 22.86, and 25.71 rpm), concluded that increasing

the disk rotation led to a reduction in the percentage of acceptable seed spacings and an increase in those classified as misses and multiples.

Carpes et al. (2016), evaluating the precision level of a horizontal holed-disk meter in soybean seed distribution at different angular speeds, observed that increasing the peripheral speed of the seed metering disk tends to reduce the precision level. However, the results remained satisfactory within the acceptable limits for precision seeding.

However, a significant difference ($p < 0.01$) was observed for the disk factor regarding double and normal cells; therefore, Tukey's means comparison test was applied.

Table 2. Summary of the analysis of variance (ANOVA) for the percentage of missed, double, and normal cells.

Source of Variation	DF	p-value		
		Missed Cells (%)	Doubles Cells (%)	Normal Cells (%)
Metering disk (D)	2	0.4939	<0.0001	<0.0001
Speed (V)	2	0.0938	0.5069	0.5628
D x V	4	0.6873	0.8602	0.8951
CV (%)	-	170%	48.70%	0.66
Shapiro-Wilk		0.100	0.2689	0.0511

Source: Prepared by the author.

The disk type did not influence the percentage of missed cells, as observed in Table 3. However, for the variable "percentage of doubles," the RampFlow disk exhibited the lowest value (0.6248%), while the tapered-hole and conventional disks showed the highest percentages (1.3840% and 1.9643%, respectively), with no statistical difference between them.

Baumel et al. (2021), in a study evaluating conventional horizontal disks and RampFlow technology on the efficiency and distribution of maize seeds (*Zea mays*) at different operating speeds, also reported results superior to the conventional disk for seedling emergence and double spacings at a speed of 5.5 km h^{-1}. Furthermore, higher seedling emergence values were obtained at speeds of 5.5 and 7 km h^{-1} when using the RampFlow-type disk.

Table 3. Means comparison test for the percentage of missed, double, and normal cells as a function of each metering disk type.

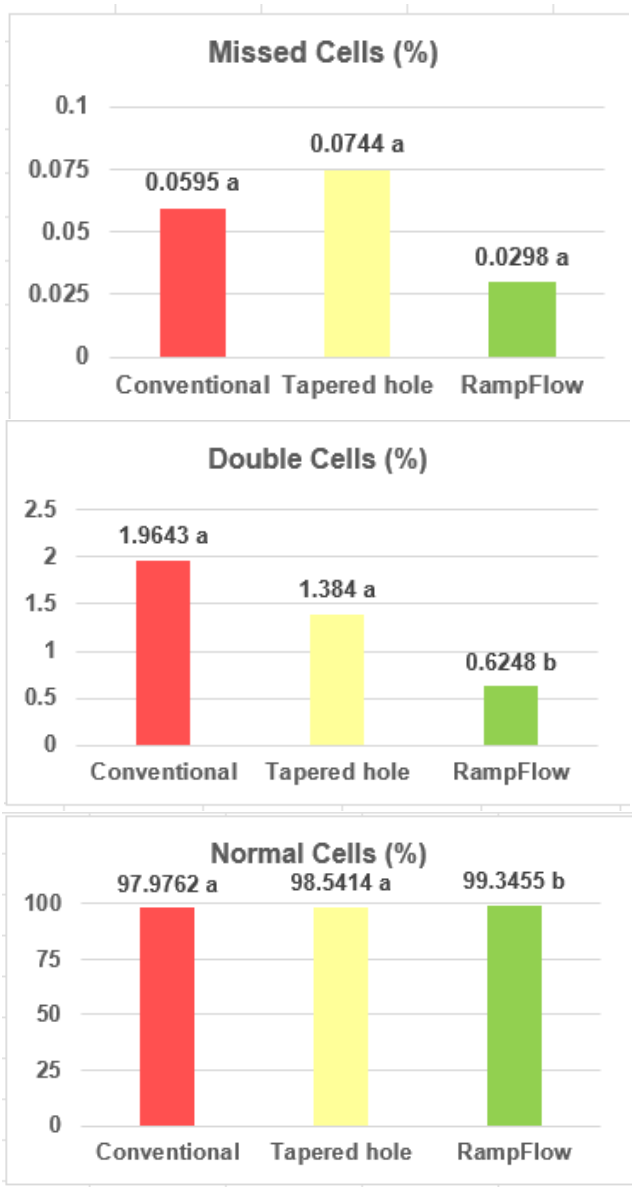
Metering Disk	Missed Cells (%)	Double Cells (%)	Normal Cells (%)
Conventional	0.0595 a	1.9643 a	97.9762 a
Tapered hole	0.0744 a	1.3840 a	98.5414 a
Rampflow	0.0298 a	0.6248 b	99.3455 b

Means followed by the same letter do not differ by Tukey's test at 5% significance.

Source: Prepared by the author.

The RampFlow disk achieved the best performance, with 99.34% normal cells, while the conventional and tapered-hole disks presented 97.97% and 98.54%, respectively. Correia et al. (2015), evaluating soybean seed distribution using a conventional horizontal disk (CD) and a RampFlow horizontal disk (RD) on a plantability belt, concluded that the acceptable indices with RD were 33.3% higher than with CD, while misses and doubles were reduced by 70.1% and 64.1%, respectively. All studied indices reflect higher precision when utilizing the RampFlow technology. Figure 3 displays the average percentage of missed, double, and normal cells as a function of the metering disk.

Figure 3. Average percentage of missed, double, and normal cells as a function of the metering disk.



Source: Prepared by the author.

CONCLUSION

The type of technology utilized in the planting disks, when evaluated on a static test stand, did not statistically influence the percentage of missed cells.

The technology present in the planting disks exerted a statistical influence on double and normal cells, with the RampFlow technology achieving a 68.19% reduction in double cells compared to the conventional disk.

The RampFlow disk technology by J. Assy demonstrates superior efficiency in seed singulation.

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