ISSN: 1984-5529

Científica

Jaboticabal

v.44, n.1, p.1–4, 2016

http://dx.doi.org/10.15361/1984-5529.2016v44n1p1-4

Longitudinal distribution of corn seeds depending on horizontal disk with different technologies

Distribuição longitudinal de sementes de milho em função de disco horizontal com diferentes tecnologias

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Recebido em: 18-09-2014; Aceito em: 29-09-2015

Abstract

The seed dosing mechanisms play a fundamental role in sowing operation. because the uniformity longitudinal distribution of seeds is one of the features that contribute most to proper the stand and to crop productivity. Thus, the aim of this work was to evaluate the accuracy and longitudinal distribution of seeds utilizing conventional horizontal disc dosimeter and and to horizontal the disc dosimeter RampFlow. The experiment was conducted at the Laboratory of plantability FCA / UNESP, Botucatu-SP, and plantability mat was used for the distribution of seeds. The treatments were: conventional horizontal disc dosimeter and and to horizontal the disc dosimeter RampFlow., both of 11.5 mm diameter of the alveoli. The results indicate that RampFlow disc has precision similar to conventional disc, however, not been verified better efficacy for Reduction of failures and with of acceptable increased technology.

Additional keywords: drill; mechanism dosing; sowing quality.

Resumo

Os mecanismos dosadores de sementes tem papel fundamental na semeadura de grãos, pois a uniformidade de distribuição longitudinal de sementes é uma das características que mais contribuem para o estande adequado e a produtividade das culturas. Sendo assim, o objetivo do trabalho foi avaliar a precisão e a distribuição longitudinal de sementes de milho utilizando disco dosador horizontal convencional e disco dosador horizontal com tecnologia RampFlow. O experimento foi conduzido no Laboratório de Plantabilidade da FCA/UNESP de Botucatu-SP, e foi utilizada esteira de plantabilidade para a distribuição de sementes. Os tratamentos foram: disco horizontal convencional e disco horizontal RampFlow, ambos com alvéolos de 11,5 mm de diâmetro. Os resultados apresentaram que os discos possuem precisão de distribuição longitudinal semelhante, não sendo constatada diferença estatística entre os tratamentos.

Palavras-chave adicionais: mecanismo dosador; qualidade de semeadura; semeadora-adubadora.

Introduction

Within the grain production process, sowing operation is a major factor for success in establishing a crop (Copetti, 2004).

According to the Brazilian Association of Technical Standards - ABNT (1994), the seeders are sorted by the way of distribution of seeds in precision seeders and continuous flow seeders. The precision seeders are machines that distribute the seeds in the planting furrow, one by one or grouped in regular rows and intervals according to the established seeding rate; in continuous flow seeders, the seeds are distributed in a row, but without precision in their deposition on the ground.

The dosage of seeds by precision seeders can be accomplished by mechanical or pneumatic precision dosing devices. Mechanical precision dosers generally have the form of perforated disks, being housed horizontally in the bottom of the seed reservoir. Pneumatic dosers are disks arranged vertically and using air as the principle of capturing of the seeds by pressure differential (Portella, 1997). The efficiency of the dosing system, according to Reis et al. (2007), is linked to the slipping of wheels of the seeder and also to the operating speed.

Garcia et al. (2011) and Trogello et al. (2013) also associate the efficiency of the dispensing disk to the uniformity of distribution of seeds, occurrence of failures, doubles and number of seeds distributed per meter. According to Silva & Gamero (2010), the uniformity of longitudinal distribution of the seeds is one of the features which contribute most to a suitable plant stand and, thus, for the improvement of crop productivity.

The uneven distribution of plants, according to Fabretti et al. (2011), impairs the productivity of maize, due to the competition between plants for the interception of solar radiation, nutrients and water from the soil, as they can explore nearby areas. According to Portela (2001) research, losses can reach 15% for corn, 35% for sunflower and 10% for soybean.

The basic parameters used to determine the seed distribution efficiency by dispensing disks are the coefficient of overall variation in spacing and the longitudinal distribution of seeds, being them the percentage of acceptable, flawed and double spacing (Kurachi et al., 1989).

In order to improve the efficiency and quality of longitudinal distribution of seeds, the seeders and their components have undergone technological innovations (Silva & Gamero, 2010). In this context, it was developed the RampFlow technology in the horizontal dispensing disks. This technology consists of horizontal disks with conical hole on one side of the seed housing cavity (alveolus), simulating a "ramp" for seed descent in the alveolus, an innovation that proposes fewer failures in the distribution of seeds and increased accuracy in sowing.

In this sense, this study aimed to evaluate the accuracy and the longitudinal distribution of corn seeds using the conventional and the RampFlow horizontal dispensing disk.

Material and methods

The experiment was conducted in the lab of plantability of the no-till group (NTG) of the Faculty of Agricultural Sciences – UNESP – Botucatu Campus-SP.

It was used a plantability treadmill (Figure 1), Socidisco® brand, equipped with 0.3 hp electric motor, horizontal disk dispensing system and canvas treadmill coated with felt measuring 3.0 m in length and 0.35 m in width. The treadmill displacement speed was of 4.3 km h^{-1} (1.19 m s^{-1}) and the seeds used were of the corn hybrid 2B587PW, with characteristic of semident grain. It was adopted population of five seeds per meter (reference distance of 200 mm between seeds).

Figure 1. Plantability Treadmill.

The dispensing disks used in the treatment were: conventional horizontal disk, Figure 2 (A), and the RampFlow horizontal disk, Figure 2 (B). Both with 11.5 mm (0.0115 m) in diameter of the alveoli (holes) and used with recessed ring, according to the recommendation described on the packaging of the seeds, produced by Dow Agrosciences.

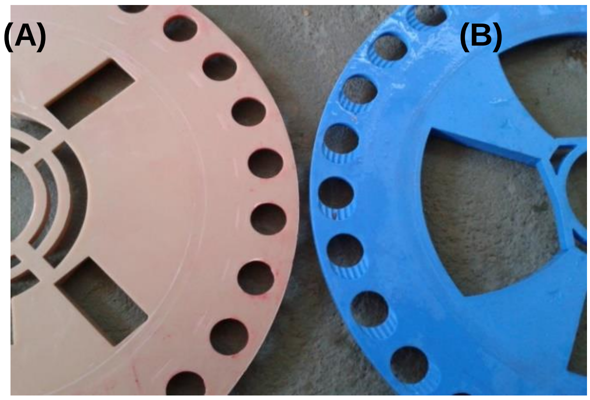

Figura 2 - 11.5 mm horizontal disk (A) and 11.5 mm RampFlow horizontal disk (B).

The spacing between the deposited seeds (SBS) were analyzed by applying the ABNT (1994) technical standard 04:015.06-004, establishing the percentage of corresponding spacing in acceptable (0.5 DS ≤ SBS ≤ 1.5 FS) double (DS ≤ 0.5 SBS) and flawed (FS ≥ 1.5 SBS). For the test, the reference spacing between seeds (SBS) was of 0.20 m, as adopted population of five seeds per meter, being classified as acceptable (0.10 m < SBS < 0.30 m), double (DS < 0.10 m) and flawed (FS > 0.30 m). The longitudinal distance between the seeds was measured using a 0.01 m precision tape.

For each treatment were performed eight repetitions, in each of them the plantability treadmill was activated and remained in operation (depositing seeds) for thirty seconds, enough time to stabilize its components and to the deposition of seeds. After the procedure, it was measured the spacing between all the seeds deposited over 3 m of length from the treadmill to the same, thus composing a repetition. The length of the treadmill is marked by a tape affixed to its side structure, illustrated in Figure 1.

To express the regularity of the spacing between seeds, it was determined the coefficient of variation of all of the sampling spacing (acceptable, double and flawed) by the Equation 1, described by Mahl (2006).

$$CV = \frac{s_1}{X} \times 100 \qquad (1)$$

Where CV is the coefficient of variation (%), S_1 is the standard deviation of all the spacing between seeds (m) and X the average of all the spacing between seeds (m).

The precision index of the seed distribution corresponded to the ratio between the standard deviation of the normal spacing and the reference spacing adopted, calculated according to Equation 2, described by Mahl (2006).

$$IP = \frac{s_2}{X_{REF}} \times 100 \qquad (2)$$

Where PI is the precision index (%), S_2 is the standard deviation of the acceptable spacing between seeds (m) and X_{REF} the reference spacing between seeds (0.20 m).

To qualify the work between the seed dispensing disks, it was conducted evaluation suggested by Tourino & Klingensteiner (1983), classifying the performance regarding the acceptable spacing. The criterion suggested by the authors classifies as great performance that which has 90-100% of acceptable spacing; good performance, from 75 to 90%; regular, 50 to 75%; and below 50%, as unsatisfactory performance.

The data obtained from each disk were subjected to analysis of variance (ANOVA) and later it was performed the mean comparison test (p<0.05) using the ASSISTAT statistical software.

Results and discussion

The data of longitudinal distribution of corn seeds by the conventional perforated disk and RampFlow are shown in Table 1.

Between the two types of disks, it was found that there is no statistical difference in the precision of distribution of seeds, as well as there is no significant difference to the average spacing values. The results of the precision index are greater than those found by Rosa et al. (2014), wherein the authors found, for the conventional disk, precision of 32.62%, and of 29.22% for the RampFlow. Although the authors do not clarify the methodology used to determine the accuracy, they concluded that there is no difference between the precision of the conventional and the RampFlow disk, similarly to this work. Nonetheless, for the results of average spacing between seeds, the authors found differences between the conventional and the RampFlow disk, from 23.7 cm (0.237 m) to 22.7 cm (0.227 m), respectively, the result of RampFlow being the one closest to the ideal spacing.

Table 1 - Indices of acceptable, flawed, double, precision and average spacing between corn seeds deposited by the conventional and the RampFlow horizontal disk.

Horizontal Disk	(1)Indices (%)				(1)Average spacing (m)	C.V. (%)
	Acceptable	Flawed	Double	Precision		
Conventional	93.75 a	6.25 a	0.0	99.57 a	0.2566 a	8.69
RampFlow	90.63 b	9.38 b	0.0	99.46 a	0.2589 a	10.89

ANOVA

F Test (Disks)	F Test (Spacing)	Interaction	C.V (%)
$0.27^{N.S}$	3.23**	$0.56^{N.S}$	9.4

(1) Means followed by the same letter do not statistically differ from each other, by Tukey test at 5% probability; C.V. - Coefficient of variation, ** significant at 1% probability, $^{N.S}$ non-significant.

The difference between the disks was significant for the acceptable and flawed rates. The conventional disk had a higher percentage of acceptable longitudinal spacing of seeds and a lower percentage of flawed, in this way, it is verified that this disk provides greater spacing regularity in the distribution of seeds, a fact proven by the coefficient of variation of 8.69%. These results for acceptable and flawed confirm the reported by Santos et al. (2011), who describe the uniform longitudinal distribution of seeds as one of the features that contribute most to a suitable plant stand and crop yield improvements.

The RampFlow disk showed higher rates of flawed and lower rates of acceptable, its coefficient of variation being greater than that of the conventional disk. These results express more irregular distribution between seeds, jeopardizing the plant stand and crop yields as described by Santos et al. (2011). The losses arising from these results are quantified and described in a study conducted by Nummer (2012), wherein, for each 10% of change in the longitudinal distribution of corn plants, on average 90 kg ha^{-1} productivity is lost.

In a study evaluating disks on field conditions and low speed of sowing of maize, 2 km h^{-1} (0.55 m s^{-1}), Rosa et al. (2014) concluded that the RampFlow disk was effective in reducing failures, from 6.86% with the conventional disk to 3.99%. Notwithstanding, for the double spacing index, the results are consistent with the present study, with no significant differences between disks.

Although the results of acceptable spacing have presented statistical difference between the horizontal and the RampFlow disk, for the qualitative performance evaluation suggested by Tourino & Klingensteiner (1983), both disks can be classified as of excellent performance, as the authors establish as a criterion those disks that have 90 to 100% acceptable spacing.

Conclusion

According to the precision index, the disk with RampFlow technology and the conventional disk have the same accuracy for the longitudinal distribution of corn seeds at a speed of 4.3 km h^{-1} (1.19 m s^{-1}), both had excellent performance according to the classification used.

The RampFlow disk did not show better efficacy in increasing the acceptable spacing and reducing failures.

Acknowledgements

The Coordination of Higher Education Personnel Improvement - CAPES, and the no-till group (NTG) of the Faculty of Agricultural Sciences of Botucatu-SP.

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