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Full Length Research Paper

Corn hybrid seed damage as a function of metering device in corn planting

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Seed quality control is becoming increasingly important, since the market is increasingly competitive. The planting operation process should occur in order to avoid mechanical damage, which may affect the seed quality. This study aimed to evaluate the effect of mechanical damage caused by meter mechanisms (mechanical and pneumatic) on physical and physiological quality of corn seeds. The experiment was carried out in a Rhodic Hapludox, Southeast Brazil. A randomized block design with 2 × 3 factorial scheme (metering mechanism x seed shape) was used. The corn variety used was a corn hybrid SYN5R27. The seed samples were collected before and after the planter run, and the seed performance was evaluated by germination, accelerated aging, cold test, emergency in the soil and determination of mechanical damages with iodine. The metering mechanisms (mechanical and pneumatic) did not affect the seed quality, except for the saturated cold test that estimates the germination potential of the seeds under adverse conditions. Due to a better adaptation of the disks, the flat seeds presented less damage.

Key words: Mechanical meter, pneumatic planter, physiological quality, planting performance.

INTRODUCTION

The corn planters available in the Brazilian market have metering devices that do not attend completely to the prerequisites of uniform spatial distribution of seeds. Like some work done, pneumatic meters show superior results compared to the seeder with mechanical meter principle, in lower densities (Tourino et al., 2007). With increasing density, seeding the performance of two machines tend to equalize statistically. This is in accordance with claims Bragachini et al. (2003). According to the authors, the high seeding rate is one factor that reduces the advantage of pneumatic distributors in relation to mechanics. Another problem of uniform spatial distribution is that the passage of the seed through the metering mechanism decreases the percentage of germination of the corn seed and decrease the plants uniformity (Garcia et al., 2011).

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According to Silva et al. (1985), the ability to provide low level of damage to seeds during the seeding process is one of the most important features of a planter, seed size and shape are important factors that influence the occurrence of mechanical injuries in seeds. Seed shapes are classified into rounded, flat and size in sieves of different meshes (Von Pinho et al., 1995). However, little attention has been given to the meter mechanism as damaging agent, even knowing that when passing through this mechanism, the seeds are under pressure making them susceptible to mechanical damage that reduce germination and vigor (Carvalho and Nakagawa, 2000).

Mechanical damages can destroy essential seed structures, increase susceptibility to microorganisms and sensitivity to fungicides, besides reducing germination, vigor, storage potential and field performance. (Carvalho and Nakagawa, 2000). Quality control programs have always been important, since the seed market is more and more competitive. Identifying the intensity and possible consequences of deteriorative processes related to the loss of physiological capacity of the seeds by combining the results of germination and vigor, tests can be an alternative for the evaluation of such issues (Marcos Filho, 2005). This study aimed to evaluate the effect of mechanical damage caused by meter mechanisms on physical and physiological quality of corn seeds.

MATERIALS AND METHODS

The experiment was carried out in Rhodic Hapludox, next to the geodetic coordinates 21°14' S and 48°17' W, with an average elevation of 595 m. The experimental design was the 2 × 3 factorial scheme, with four replications. The treatments were two metering mechanisms (mechanical and pneumatic), common in precision planters, and three corn seed shapes, classified into a flat sieve (20F), which the seed passing through the sieve presented 5.16 mm diameter, round (20R), which seeds were retained on the 6.35 mm sieve; and thick (20T), which seeds were retained on 5.16 mm sieve. The corn variety used was a corn hybrid SYN5R27. For the planting operation, we used two precision planters: a pneumatic planter, COP Suprema 7/4 model, and a mechanical planter, PST² model, both with double discs for fertilizer and seed distribution. The characteristics of each metering mechanism to seed distribution are present in the Table 1.

The planter was equipped with 4 planting rows and in each of them we placed plastic bags in the conductor to collect the seeds. The corn evaluations were:

Moisture degree

This was determined before the installation of the tests, by the oven method at 105°C (± 3°C) for 24 h in two samples. The results were expressed as average percentage (wet basis) per sample.

Germination test

This was conducted with four replications of 50 seeds, in moistened paper towel rolls with an amount of water equivalent to 2.5 times the paper mass at 25°C for seven days.

The readings were conducted in accordance with the rules for seed analysis (Brasil, 2009) and the results were expressed as a mean percentage of normal seedlings for each sample.

Accelerated aging

The method used was the mini-chambers, and then the seeds were distributed in a single layer on a suspended screen inside a plastic box (11 × 11 × 3 cm), containing 40 ml of water. The seeds remained incubated for 96 h at 41°C (AOSA, 1983). After this period, we conducted the germination test and were considered the percentage of normal seedlings on the fifth day after planting.

Saturated cold test

Four samples of 50 seeds were sown in substrate composed of sand and soil mixture in 3:1 ratio in trays, placing the embryo upside down, pressing gently to make it parallel to the soil surface, so that the substrate involves the entire embryo, and preventing contact with the oxygen. The trays were placed in a cold chamber at 10°C for 4 days, and then, in the incubator for 3 days at 25°C, the aerial part that determined the percentage of normal seedlings was analyzed (Caseiro and Marcos Filho, 2000). Emergency in the soil: the seeds were exposed to conditions of temperature and substrate similar to those expected at the time of sowing in the greenhouse. A layer about 5 cm thick of soil was put in plastic boxes, where the seeds were placed and also covered with a layer of 1 to 2 cm of soil. It was evaluated after 7 days, and then we analyzed the total of normal seedlings emerged according to the rules for seed Analysis (Brasil, 2009).

Test to determine mechanical damage with iodine

The seeds were placed in boxes, added 150 ml of water and 10 ml of 2% iodine. Within 5 min the seeds as slight damage were evaluated (endosperm) and deep damage (embryo) (Marcos Filho et al., 1987).

Statistical analysis

The statistical programs used were the Sisvar (Ferreira, 2011) and Assistat, resulting in analysis of variance by F test of Snedecor and, when significant, we applied the Tukey test at 5% of probability ($p < 0.05$).

RESULTS AND DISCUSSION

The water content in the corn seeds (Table 2) showed very close behavior, being 0.4% the biggest difference, so it did not affect the study. The pneumatic and mechanical meter mechanisms did not affect significantly the physiological quality of the seeds (Table 3), when these were evaluated by the germination and accelerated aging tests. However, when these mechanisms were compared by the cold test, the vigor decreased when using the mechanical meter mechanism. These results agree with those obtained by Wortman and Rinke (1951), which noted efficiency of the cold test to stratify seed lots

Table 1. Characteristics of the metering mechanism for seed distribution.

Metering characteristics	Pneumatic	Mechanical
Disc type	Vertical	Horizontal
Holes to seed distribution	32	28
Hole diameter (mm)	5	12 15

Table 2. Water content of the corn seeds.

Meter Mechanisms	Seed shape	Water content (%)
Pneumatic	Thick	10.2
	Flat	10.4
	Round	10.2
Mechanical	Thick	10.0
	Flat	10.2
	Round	10.0

Table 3. Germination accelerated aging and saturated cold tests of different seed shapes after passing through the meter mechanisms.

Treatments	Germination	Cold Test	Accelerated aging
		(%)	
Meter mechanisms (M)			
Pneumatic	98.60	94.92^{a}	98.42
Mechanical	98.60	93.08^{b}	98.50
Seeds (SE)			
Thick	98.40	95.25^{a}	98.50^{ab}
Flat	99.12	94.00^{ab}	98.50^{a}
Round	98.25	92.75^{b}	97.50^{b}
F Test			
M	0.00^{NS}	6.368*	0.027^{NS}
SE	1.99^{NS}	3.947*	4.503*
MxSE	1.80^{NS}	1.474^{NS}	1.785^{NS}
CV (%)	0.96	1.89	1.27

Means followed by different letters in the column differ by Tukey test at 5% probability. CV: coefficient of variation.

with different levels of mechanical damage, Borba et al. (1994) noted in the seeds of maize hybrid BR 201, a reduction in vigor, in an immediate and significant way with the increase in mechanical damage. The germination test was conducted under conditions considered as optimal environment and therefore must provide the theoretically maximum germination that may be expected in certain sample. This information is very important because it sets limits to the performance of the seed lot after planting (Marcos Filho, 2005). For the three seed sizes (thick, flat and round), after passing through the pneumatic and mechanical meter mechanisms (Table 4), there was a lower performance for round seed. In studies developed with corn seeds, there was a trend of

Table 4. Emergence test in soil and mechanical damage (slight and deep) according to the meter mechanisms and seed shapes.

Treatments	Emergence in the soil	Slight damage	Deep damage
	------------------------------ (%) ---------------------------------		
Meter mechanisms (M)			
Pneumatic	98.50	8.29	1.80
Mechanical	98.08	10.00	2.70
Seeds (SE)			
Thick	98.62	9.38^{b}	1.63^{ab}
Flat	98.08	1.69^{a}	0.75^{a}
Round	97.25	16.38^{c}	4.37^{b}
F test			
S	2.19^{NS}	1.53^{NS}	0.87^{NS}
SE	14.28**	37.80*	4.98*
MxSE	5.35*	1.03*	0.66^{NS}
CV (%)	0.70	36.95	106.55

Means followed by different letters in the column differ by Tukey test at 5% probability. CV: coefficient of variation.

Table 5. Interaction between treatments for Emergence in the soil.

Emergency in the soil (%)		Seed characteristics		
		Thick	Flat	Round
Meter mechanisms	**Pneumatic**	98.25^{Ab}	99.25^{Aa}	98.00^{Aa}
	Mechanical	99.00^{Aa}	98.75^{Ab}	96.50^{Ba}

Means followed by different lowercase letters in columns and uppercase letter in the rows differ by Tukey test at 1% probability.

Table 6. Interaction between treatments for slight mechanical damages.

Slight mechanical damages (%)		Seed characteristics		
		Thick	Flat	Round
Meter mechanisms	**Pneumatic**	9.12^{Ba}	1.62^{Aa}	14.12^{Ba}
	Mechanical	9.62^{Ba}	1.75^{Aa}	18.62^{Ca}

Means followed by different lowercase letters in columns and uppercase letter in the rows differ by Tukey test at 1% probability.

round seeds presenting higher incidence of mechanical damage than the flat seeds. In the round seeds, the embryonic axis occupy a very exposed position facilitating the damage (Menezes et al., 2002).

For the planter with pneumatic mechanism, the seed size did not influence the emergence(Table 5), however, for the mechanical meter the round seed obtained the worst result, probably due to the largest damages presented (Table 6). This type of seed did not present difference for the two distribution mechanisms tested. The seed emergence was better in the mechanical meter in relation to the pneumatic in thick seed, but with the flat seed, the opposite occurred. It can be explained by the greatest requirement for air suction to hold the thick seed. The flat seeds presented better results when compared to others, lower than 2%. For the pneumatic meter mechanism there was no difference between thick and the round shape, however, in the mechanical meter the round seed had higher amount of slight damages in relation to the thick and flat seed. George et al. (2003) also observed a higher percentage of injuries in the pericarp observed to round seeds when compared to flat seeds.

The deep damages were not affected by the mechanical and pneumatic meter (less than 3%). However, the flat seed shape presented less deep damage than the round shape. The thick seed was in the middle position.

Conclusion

The meter mechanisms (mechanical and pneumatic) did not affect the seed quality, except for the saturated cold test that estimates the germination potential of the seeds under adverse conditions. Due to a better adaptation of the disks, the flat seed presented less damage.

Conflict of interest

The authors have not declares any conflict of interest

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