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Yield and physiological quality of corn seeds after application of detasseling techniques in two cropping seasons

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Abstract

Detasseling is an essential practice in maize seed production to obtain hybrids. Due the difficulty in carrying out the detasseling in a standardized way, the objective of this study was to evaluate the yield and physiological quality of maize seeds after using detasseling techniques in two cropping seasons. The experiment was carried out in Pitangueiras - PR, using corn progenitors of the commercial hybrid Balu 761. The experimental design was randomized blocks with 4 replications. The factorial scheme was 6 × 2, with 6 detasseling techniques: removal of the tassel only (D_0); tassel removal + 1 sheet (D_1); tassel removal + 2 leaves (D_2); tassel removal + 3 leaves (D_3); tassel removal + 4 leaves (D_4); and tassel removal + 5 leaves (D_5), and 2 cropping seasons: cropping season 1 (2014) and cropping season 2 (2015). The variables analyzed were: seed yield (kg ha^{-1}), germination (%) and seed vigor from the accelerated aging (%) and cold test (%). The results showed that detasseling of maize progenitors of the Balu 761 hybrid must be carried out with the removal of the tassel only, considering that the removal of leaves during this practice is capable of reducing seed yield by up to 25%. The removal of the tassel with up to five leaves does not affect the physiological quality of the maize seeds. The cropping season influenced the seed yield, as well as seed germination and vigor from the cold test.

Keywords: germination; manual detasseling; tassel; vigor; *Zea mays*.
Abbreviation: 1st_first; 2nd_second; 3rd_third; °C_degrees Celsius; CV _ coefficient of variation; DF _ degrees of freedom; g_gram; h_hour; kg ha^{-1}_ kilo per hectare; m_meter; mL_millimeter; MS _ mean squares; %_ percentage; S_south; SS _ sum of squares; W_west.

Introduction

Maize (*Zea mays* L.), belongs to the Poaceae family, is one of the pillars of Brazilian agriculture, considering that the culture has been showing advances in relation to cultivated area, yield and total maize production in the country (1st, 2nd and 3rd crop). With a cultivated area of approximately 21,116.7 million hectares and an estimated production of 112,341.1 million tons (21/22 cropping season), maize production has increased by approximately 23% compared to the 20/21 cropping season, when it reached 87,055.1 million tons in Brazil (Conab, 2022).

Originated in the Americas, maize has an important socioeconomic role, serving as raw material for several segments, whether in animal feed or in high-tech industries, which makes it one of the most important commodities in the Brazilian agricultural sector (Duarte et al., 2008; Pereira et al., 2012).

Due the success of Brazilian maize grain yield, the seed production of high quality is necessary, which is the main factor that contributes to national production reaching worldwide prominence. It is known that the physiological quality of the seeds is related to the speed of the metabolic processes, which results in the speed and uniformity of the emission of the primary root in the germination, with reflection in the growth rate and in the vigor and initial size of the seedlings (Schuch et al., 1999). Therefore, sowing seeds with low physiological quality have direct effect on emergence in the field due to reduction in the percentage of emergence, the demand for more time to emerge and the high non-uniformity (Hosf et al., 2004).

The detasseling of female maize rows is the most used practice for the control of crosses in obtaining maize hybrids in seed production fields. Detasseling consists of removing tassels from plants that are considered females at the beginning of flowering, before the release of pollen, thus avoiding self-pollination (Magalhães et al., 1999; Martin et al., 2007).

The single and exclusive removal of the tassel has shown to be able to produce increases in the productivity of maize seeds, due to the targeting of photoassimilates that would be required for pollen formation, contributing to the development of the seeds. In addition, this technique can contribute to the increase in seed productivity, given the lower shading of photosynthetically active leaves, after the removal of tassels (Daros et al., 2000; Magalhães et al., 1999).

However, during the detasseling technique, leaf(s) may be

removed manually or mechanically, altering the balance of the source/drain ratio. An imbalance in this relationship can directly affect seed production, since about 50% of the accumulated carbohydrates come from the leaves located in the upper third of the stem, which are the most efficient in terms of grain yield (Fornazieri Filho, 2007; Alvim et al., 2010).

Due to the growing demand for the cultivation of maize, larger areas are increasingly demanded for the production of hybrid seeds. Therefore, the removal of tassels must be fast, increasing the need for the use of mechanical equipment. Magalhães et al. (1999), simulated a mechanical detasseling with the aid of scissors to cut the tassel at a predetermined height of the plants. They found that this practice caused a 9% reduction in seed productivity.

Komatuda et al. (2006), compared mechanized and manual methods and observed that mechanized detasseling caused greater damage to the upper leaves of maize, reducing yield by up to 24.5%, when the machine was set to remove 90% of the tassels with a pneumatic system. They also observed that the removal of the tassel only significantly altered the vigor of the flat seeds, when compared to the standard detasseling. However, the same authors found that the detasseling methods did not influence the germination and the vigor of round-shaped seeds, while another study did not found effect of defoliation on maize seed vigor (Menezes and Cícero, 1994).

Given the importance of the detasseling technique in the production of maize hybrids and the difficulty in carrying out the detasseling in a standardized way, the present study aims to evaluate the yield and physiological quality of maize seed under detasseling techniques in two cropping seasons.

Result

Analysis of variance of the variables: yield, germination and vigor

The analysis of variance of the variables yield, germination and vigor from the accelerated aging and cold tests of maize seeds of the Balu 761 hybrid submitted to different detasseling techniques in two cropping seasons (Table 1). Thus, it is possible to observe that the interaction between the factors was not significant for any of the variables evaluated. For this reason, we will analyze the variables according to individual factors (detasseling and cropping season).

Seed yield under detasseling techniques

Only the seed yield variable showed a significant difference due to the detasseling techniques. For the other variables, the detasseling techniques had no significant effect, showing that the detasseling, whether manual or mechanized, which perhaps removing the tassel together with the removal of up to 5 leaves in the maize plant does not change the physiological quality of the seeds produced (Table 1).

As for the cropping season factor, it had a significant effect for the variables seed yield, germination and seed vigor from the cold test. The seed vigor variable from the accelerated aging test did not present a significant effect for any of the evaluated factors (Table 1).

From Table 2, it is possible to observe that there was a cropping season effect for the seed yield variable, with a higher average in the 2015 cropping season. For the effect of detasseling, there was also a statistical difference for seed yield, because when increasing the number of leaves removed during the detasseling process, there was a decrease in the variable. Sangoi et al. (2006) also observed that for one of the evaluated cropping seasons, the grain yield of all hybrids studied responded to detasseling.

Wilhelm et al. (1995), evaluated the removal of the tassel along with 0, 1, 2, 3 and 4 leaves. They also found similar effects, since they concluded that the removal of leaves during detasseling is capable of reducing the leaf area index, the grain and straw productivity, the yield as a result of the decrease in grain size and the total concentration of nitrogen in the grain. Thus, these authors justified that the loss of photosynthetic capacity is one of the reasons for the results obtained.

Komatuda et al. (2006), when evaluating mechanical and manual methods in maize detasseling. They observed that the technique, when performed mechanically, causes greater damage to the upper leaves, being able to reduce productivity by approximately 25%. In the present study, a 25% reduction was also observed when comparing treatment D_0 (removal of the tassel only) with treatment D_5 (tassel removal + 5 leaves) (Figure 1).

Germination and seed vigor under detasseling techniques

The cropping season factor also provided a significant effect for the variables germination and seed vigor from the cold test, with higher averages being obtained in the 2014 cropping season (Table 2). Nonetheless the detasseling factor did not influence the variables germination and vigor of seeds from the accelerated aging (data not shown) and cold tests. Similar results were obtained by Menezes and Cícero (1994), who did not observe any influence of the removal of up to three leaves during detasseling on the germination and vigor of maize seeds. Wilhelm et al. (1995) observed that germination at high and low temperatures and germination at high temperatures after accelerated aging were not affected by the removal of 0, 1, 2, 3 or 4 leaves during detasseling.

It should be noted that the germination percentages obtained in both cropping seasons and in the different detasseling techniques showed higher averages than those required by legislation (minimum of 85%). Therefore, they can be applied to the production of seed (Brasil, 2003).

Detasseling techniques in seed-producing areas

In seed-producing areas, this practice should be opted because the seed yield variable has shown higher values when only tassel removal is performed, considering that this factor is directly related to the profitability of the seed producer. Therefore, equipment and qualified labor are necessary to carry out the detasseling in areas producing maize seeds.

Magalhães et al. (1999), recommended the manual detasseling or the use of male-sterility is in a hybrid seed production field. Cartridge pullout and mechanical detasseling are considered techniques capable of negatively affecting seed production. They also mention that the standard manual detasseling, with the removal of the "cartridge", can harm the plant, since, in this operation, 4 to 5 upper leaves are removed. The reduction of leaf area in maize plants, in this case, caused by detasseling, alters the physiological activity and consequently the seed yield.

Table 1. Analysis of variance of the variables yield (kg ha^{-1}), germination (%) and vigor from the accelerated aging (%) and cold (%) tests of maize seeds of the Balu 761 hybrid submitted to different detasseling techniques in the 2014 and 2015 cropping seasons.

SEED YIELD (kg ha^{-1})					
Sources of variation	DF	SS	MS	Fc	*p*-value
Detasseling (D)	5	9,327,783.85	1,865,556.77	14.876	0.0000*
Cropping season (C)	1	619,938.02	619,938.02	4.943	0.0331*
D × C	5	341,533.85	68,306.77	0.545	0.7410^{NS}
Block	3	35,293.23	11,764.41	0.094	0.9631
Error	33	4,138,375.52	125,405.32		
Total	47	14,462,924.48			
CV (%)	6.87				
SEED GERMINATION (%)					
Sources of variation	DF	SS	MS	Fc	*p*-value
Detasseling (D)	5	3.00	0.60	0.293	0.9134^{NS}
Cropping season (C)	1	33.33	33.33	16.276	0.0003*
D × C	5	22.42	4.48	2.189	0.0792^{NS}
Block	3	10.92	3.64	1.777	0.1707
Error	33	67.58	2.05		
Total	47	137.25			
CV (%)	1.51				
SEED VIGOR – ACCELERATED AGING TEST (%)					
Sources of variation	DF	SS	MS	Fc	*p*-value
Detasseling (D)	5	168.44	33.69	2.038	0.0989^{NS}
Cropping season (C)	1	0.19	0.19	0.011	0.9158^{NS}
D × C	5	116.94	23.39	1.415	0.2447^{NS}
Block	3	9.73	3.24	0.196	0.8984
Error	33	545.52	16.53		
Total	47	840.81			
CV (%)	4.62				
SEED VIGOR – COLD TEST (%)					
Sources of variation	DF	SS	MS	Fc	*p*-value
Detasseling (D)	5	7.85	1.57	0.318	0.8986^{NS}
Cropping season (C)	1	88.02	88.02	17.818	0.0002*
D × C	5	19.35	3.87	0.784	0.5689^{NS}
Block	3	50.73	16.91	3.423	0.0283
Error	33	163.02	4.94		
Total	47	328.98			
CV (%)	2.40				

*Significant = *p*-value ≤ 0.05;^{NS} = Not significant.

The exclusive removal of the tassel, which is a strong drain, may favor the plant, by reducing the competition between tassel and ear for photoassimilates, since its removal allows greater light interception by the upper leaves. The entire maize leaf area has its share in the production of photoassimilates. However, the physiologically active leaf extension above the ear is characterized as the most efficient in seed yield (Alvim et al., 2010).

Material and methods

Study area characterization and plant material

The experiment was carried out at Fazenda Alto Alegre, located in the municipality of Pitangueiras-PR, 23° 14' 33'' S and 51° 33' 05'' W, in the 2014 and 2015 crop seasons, both with sowing in February. In this study we used maize parents of double hybrid Balu 761 of early cycle.

Experimental design and treatments

The experimental design was randomized blocks (RBD), with four replications. The factorial scheme was 6 × 2, with 6 detasseling techniques, performed manually at pre-flowering, 64 days after sowing: removal of the tassel only (D_0); removal of the tassel + 1 leave (D_1); tassel removal + 2 leaves (D_2); tassel removal + 3 leaves (D_3); tassel removal + 4 leaves (D_4); and tassel removal + 5 leaves (D_5) and 2 cropping seasons: cropping seasons 1 (2014) and cropping seasons 2 (2015). The removal of the leaves always occurs in the sequence of proximity to the tassel, according to each treatment.

The experimental plots, for each treatment, consisted of six lines of females and one line of the pollinator, with a spacing of 0.70 m between lines. At the time of harvest, the lateral lines and the pollinator were discarded, and the useful area harvested consisted of the two central lines of 5.00 m.

Table 2. Averages of the variables yield (kg ha^{-1}), germination (%) and vigor from the accelerated aging (%) and cold (%) tests of maize seeds of the Balu 761 hybrid submitted to different detasseling techniques in the 2014 and 2015 cropping seasons.

SEED YIELD (kg ha^{-1})			
Detasseling	Cropping season		Total
	2014	2015	
D_0	5,625.00	6,022.50	5,823.75 a
D_1	5,140.00	5,645.00	5,392.50 b
D_2	5,183.75	5,257.50	5,220.63 b
D_3	5,078.75	5,210.00	5,144.38 b
D_4	4,948.75	4,998.75	4,973.75 b
D_5	4,261.25	4,467.50	4,364.38 c
Total	5,039.58 B	5,266.88 A	
SEED GERMINATION (%)			
Detasseling	Cropping season		Total
	2014	2015	
D_0	95.25	94.25	94.75
D_1	94.25	94.75	94.50
D_2	95.00	93.75	94.38
D_3	96.25	94.00	95.12
D_4	96.50	92.50	94.50
D_5	95.50	93.50	94.50
Total	95.46 A	93.79 B	
SEED VIGOR – COLD TEST (%)			
Detasseling	Cropping season		Total
	2014	2015	
D_0	93.00	91.75	92.38
D_1	94.00	92.00	93.00
D_2	94.00	91.75	92.88
D_3	93.75	91.75	92.75
D_4	93.75	90.00	91.88
D_5	95.50	90.50	93.00
Total	94.00 A	91.29 B	

Means followed by different lowercase letters, in the column, for the effect of detasseling and by different uppercase letters, in the row, for the effect of the cropping season, differ from each other by the Scott-Knott test at 5% probability (p-value ≤ 0.05).

Traits measured

Seeds were harvested when reached between 28 and 30% moisture. The variables analyzed were:

- Seed yield: with the aid of a maize thresher, model LC 50, the cobs were discarded. The seeds were placed in a drying chamber with indirect fire at 40°C for 72 h, when they reached 13% moisture. Then, they were weighted using a precision balance, and the results were expressed in kg ha^{-1} for each experimental unit.
- Germination test: were used four subsamples of 50 seeds per treatment, which were arranged on sheets of Germitest paper, moistened with distilled water at a rate of 2.5 times the dry mass of the substrate. Then, the rolls of paper were placed in a germinator at 25°C. The evaluation was carried out eight days after the installation of the test and the results were expressed in percentage of germination (%) (Brasil, 2009).
- Accelerated aging test: carried out with four subsamples of 50 seeds, which were distributed on a metallic screen fixed inside crystal polystyrene boxes (Gerbox® type), in order to form a single layer. In each box 40 mL of distilled water was added and then placed in an aging chamber at 42°C for 60 h (Marcos Filho, 2015). Subsequently, the seeds were submitted to the germination test, according to the methodology described by Brasil (2009). The evaluation was carried out four days after the installation of the test and the results were expressed in percentage of seed vigor (%).
- Cold test: performed with four subsamples of 50 seeds, which were placed on sheets of Germitest paper, moistened with distilled water at a rate of 2.5 times the dry mass of the substrate. Then, the paper rolls were placed in sealed plastic bags, which were placed in germinators regulated at a constant temperature of 10°C for 7 days (Barros et al., 1999). After this period, the paper rolls were removed from the bags and transferred to germinators at a temperature of 25°C for four days, when the percentage of seed vigor (%) was evaluated (Brasil, 2009).

Statistical analysis

The data obtained showed normal distribution and homogeneity of variances. Therefore, there was no need for data transformation. They were submitted to analysis of variance and the means were compared by the Scott-Knott test, at 5% probability.

Conclusion

Detasseling of maize progenitor of the Balu 761 hybrid must be carried out with the removal of the tassel only, considering that the removal of leaves during this practice is capable of reducing seed yield by up to 25%. The removal of the tassel with up to five leaves does not affect the

physiological quality of the seeds. The cropping season is able to influence seed yield, as well as seed germination and vigor from the cold test.

References

Alvim KRY, Brito CH, Brandão AM, Gomes LS, Lopes MTG (2010) Quantificação da área foliar e efeito da desfolha em componentes de produção de milho. Ciênc Rural. 40.

Barros ASR, Dias MCLL, Cícero SM, Krzyzanowski FC (1999) Teste de frio. In: Krzyzanowski FC, Vieira RD, França Neto JB (eds.) Vigor de sementes: conceitos e testes, 1st edn. Abrates, Londrina.

Brasil (2004) Serviço Nacional de Proteção de Cultivares. Legislação brasileira sobre sementes e mudas: Lei nº 10.711, de 5 de agosto de 2003 e Decreto nº 5.153, de 23 de julho de 2004. MAPA, Brasília.

Brasil (2009) Regras para análise de sementes. Mapa/ACS, Brasília.

Conab (2022) Acompanhamento da safra brasileira: grãos - safra 2021/22, 6º levantamento. Conab, Brasília.

Daros E, Ronzelli Júnior P, Costa JA, Koehler HS (2000) Estresses por sombreamento e desfolhamento no rendimento e seus componentes da variedade de feijão "carioca". Sci Agrar. 1:55–61.

Duarte JO, Cruz JC, Garcia JC, Mattoso MJ (2008) Economia da produção. In: Cruz JC (ed.) Cultivo do milho, 4th edn. Embrapa Milho e Sorgo, Sete Lagoas.

Fornasieri Filho D (2007) Manual da cultura do milho, 1st edn. Funep, Jaboticabal.

Hosf A, Schuch LAB, Peske ST, Barros ACSA (2004) Emergência e crescimento de plântula de arroz em resposta à qualidade fisiológica de sementes. Rev Bras Sementes, 26:92–97.

Komatuda AS, Santos CM, Santana DG, Souza MA, Brito CH (2006) Influência de métodos de despendoamento na produtividade e na qualidade das sementes de milho. RBMS. 5:359–368.

Magalhães PC, Durães FOM, Oliveira AC, Gama EEG (1999) Efeitos de diferentes técnicas de despendoamento na produção de milho. Sci Agric. 56:77–82.

Marcos Filho J (2015) Fisiologia de sementes de plantas cultivadas, 1st edn. Abrates, Piracicaba.

Martin TN, Tomazella AL, Cícero SM, Dourado Neto D, Favarin JL, Vieira Júnior PA (2007) Questões relevantes na produção de sementes de milho - Primeira parte. Revista da FZVA. 14:119–138.

Menezes NL, Cícero SM (1994) Efeitos da antecipação do despendoamento em plantas de milho sobre a área foliar, produção e qualidade de sementes. Pesqui Agropecu Bras. 29:733–741.

Pereira MJR, Bonan ECB, Garcia A, Vasconcelos RL, Gíacomo KS, Lima MF (2012) Características morfoagronômicas do milho submetido a diferentes níveis de desfolha manual. Rev Ceres. 59:200–205.

Sangoi L, Guidolin AF, Coimbra JLM, Silva PRF (2006) Resposta de híbridos de milho cultivados em diferentes épocas à população de plantas e ao despendoamento. Ciênc Rural. 36:1367–1373.

Schuch LOB, Nedel JL, Assis FN, Maia MS (1999) Crescimento em laboratório de plântulas de aveia-preta (*Avena strigosa* Schreb.) em função do vigor das sementes. Rev Bras Sementes. 21:229–234.

Wilhelm WW, Johnson BE, Schepers JS (1995) Yield, quality, and nitrogen use of inbred corn with varying numbers of leaves during detasseling. Crop Sci. 35:209–212.