AGRONOMY (AGRONOMIA)

Revista Brasileira de Ciências Agrárias
ISSN (on line) 1981-0997
v.14, n.3, e5674, 2019
Recife, PE, UFRPE. www.agraria.pro.br
DOI:10.5039/agraria.v14i3a5674
Protocolo 5674 - 05/03/2018 • Aprovado em 23/04/2019

Quality of soybean seeds with different lignin content obtained from desiccated plants

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ABSTRACT: Soybean farmers have been using desiccation to anticipate harvesting, however, this technique is frequently questioned when used in seeds production fields, since residues left by desiccants may harm the seeds quality, especially those with fragile tegument. The aim of this study was to evaluate how desiccants applied in different times affect the quality of soybean seeds with different lignin content in the tegument. Plants of cultivars BRS Silvânia RR, BRS Valiosa RR, BRS 245 RR, and BRS 247 RR were desiccated with three commercial herbicides, besides one control treatment, in three application times, when seeds showed 30, 40, and 50% of water content. Seeds quality was evaluated performing the tests of germination, emergence, emergence speed index, accelerated aging, electrical conductivity, tetrazolium and seed yield. The lignin content in soybean seeds has high negative correlation with seed yield and with traits related to the seeds quality. In general, the plants desiccation with the herbicide Finale® harms the seeds quality.

Key words: desiccants; *Glycine max*; vigor

Qualidade de sementes de soja com diferentes teores de lignina obtidas de plantas dessecadas

RESUMO: Produtores de soja tem utilizado herbicidas dessecantes para antecipar a colheita, entretanto, essa prática é frequentemente questionada quando utilizada em campos de produção de sementes, uma vez que os resíduos deixados pelos herbicidas dessecantes podem prejudicar a qualidade das mesmas, especialmente daquelas com tegumento frágil. O objetivo nesse estudo foi avaliar como dessecantes aplicados em diferentes épocas afetam a qualidade de sementes de soja com diferentes teores de lignina no tegumento. Plantas das cultivares BRS Silvânia RR, BRS Valiosa RR, BRS 245 RR e BRS 247 RR foram dessecadas com três herbicidas comerciais, além de um tratamento controle, em três épocas de aplicação, quando as sementes estavam com teores de água de 30, 40 e 50%. A qualidade das sementes foi avaliada pelos testes de germinação, emergência, índice de velocidade de emergência, envelhecimento acelerado, condutividade elétrica, tetrazólio e produtividade. Para o teor de lignina das sementes de soja há alta e negativa correlação com a produtividade e os caracteres relacionados à qualidade fisiológica das sementes. A dessecação das plantas com o herbicida Finale® prejudica a qualidade das sementes.

Palavras-chave: dessecantes; *Glycine max*; vigor

Introduction

Many factors affect the quality of soybean seeds during production process, where performing a careful harvesting is one of the most important factors to obtain high quality seeds. Soybean seeds reach the maximum quality close to physiological maturity, when their dry matter, vigor and germination are the highest. From that time, leaving the crop in the field may lead to a significant reduction in seeds quality. However, when seeds are in the period of physiological maturity, their water content is very high, making mechanical harvesting unfeasible. Thus, desiccating plants before harvesting has been indicated in order to equalize seeds maturation, anticipate harvesting, control weeds, and minimize losses on seeds quality (Lamego et al., 2013).

The decision of using desiccants in seeds production fields should be careful, because some herbicides used to desiccate plants leave residues that may favor the fungus development and reduce seeds vigor. The occurrence and intensity of the damages are directly related to the environmental conditions at the time of application, to the seeds development stage, and to the seeds tegument characteristics (Pereira et al., 2015).

The lignin present in the tegument directly determines the seeds quality, which is associated to the seeds susceptibility to mechanical damages, and to the seeds permeability, durability, and potential deterioration (Gris et al., 2010; Baldoni et al., 2013). Studies showed that lignin is one of the most important seeds contents related to the resistance of the soybean seeds to pathogens and to absorb water. According to Gris et al. (2016), the seeds impermeability afforded by lignin has a significant effect on the capacity and speed of water absorption.

Despite it is an important issue, studies relating the quality of soybean seeds and the lignin content in the tegument are restricted, especially involving other factors of the production system. The aim of this study was to evaluate the physiological quality of soybean seeds with different lignin content in the tegument obtained from plants desiccated using different herbicides applied in different times.

Material and Methods

The experiment was carried out using the randomized block experimental design with 3 replications, in a factorial system 4 x 4 x 3, consisting of 4 soybean cultivars, 4 desiccants, and 3 times of application. The commercial cultivars were BRS Silvânia RR, BRS Valiosa RR, BRS 245 RR and BRS 247 RR. The desiccants were the herbicides Reglone® (diquat, 2L ha^{-1}), Gramoxone® (paraquat, 2.5L ha^{-1}), Finale® (ammonium glufosinate, 3L ha^{-1}) and water as control treatment. All herbicides were applied using a CO^2 knapsack sprayer with constant pressure (2.0kgf cm^{-2}), and spray volume of 200L ha^{-1}. The application times were determined due to the seeds water content: 1st time = 50% of water content, 2nd time = 40% of water content, and 3rd time = 30% of water content. Plots consisted of 3 lines of 5 m, spaced 0.5 m, added of 2 lines, one in each side of the plot, constituting the border. Plants were manually harvested when their seed water content was around 18-20%, and left to natural drying until achieving water content of 13%.

The lignin content was obtained from seeds tegument dried at 55°C for 48 hours. First, the teguments were crashed with liquid nitrogen until they formed powder. The samples were washed twice with 1.5 mL of Triton and centrifuged at 10,000 rpm for 10 minutes. After discarding the supernatant, the precipitate was washed with 1.5 mL of distilled water, centrifuged again and the supernatant discarded. Samples were dried in a VAC integrated system (“Liobras” brand, model L101) for 8 hours. Part of the sample was stored in a desiccator for future extraction and quantification of lignin. The other part was added of 1.5 mL methane 80% and put in a rotary shaker for 15 hours protected from light. Then, the sample was centrifuged at 12,000 rpm for five minutes and dried at 65°C for four hours, after discarding the supernatant. The lignin content was obtained from the lignin curve based on the absorbance measured at 280 nm, with lignin expressed in grams percent (g%) of dry tissue (tegument), according to the methodology used by Capeleti et al. (2005).

The seeds physiological quality was evaluated after seed processing by the following tests: germination, seedlings emergence, emergence speed index, accelerated aging, electrical conductivity and tetrazolium test.

Germination test (G) was performed using two subsamples consisting of 50 seeds of each plot, accounting 300 seeds by treatment. The seeds were distributed on Germitest® paper moistened with water amount equivalent to 2.5 times the mass of dry substrate, and maintained in germination chamber at 25 °C degrees. Two counts of the number of normal seedlings were performed at five (G5) and eight (G8) days after sowing (Brasil, 2009).

The seedlings emergence (E) was evaluated sowing two subsamples of 50 seeds from each plot in plastic trays with two parts of sand per one part of soil, the moisture content of the substrate was maintained at 60% of field capacity with daily irrigations, and maintained in a 25 °C growth chamber alternating 12 hours of light and 12 hours of dark. It was considered the number of normal seedlings at 14 days after sowing. Seedling counts were also performed daily, and the emergence speed index (ESI) was calculated according to Maguire (1962), at the end of the 14th day.

The accelerated aging test (AA) was performed according to Dutra & Vieira (2004), the seeds were artificially aged by placing them in a screen inside a plastic box (gerbox) with 40 mL of water, kept in a biochemical oxygen demand (BOD) chambers for 48 hours at 42 °C. Then, the seeds were put to germinate as in the germination test, accounting the percentage of normal seedlings at the 5th day after sowing.

For the electrical conductivity test (EC), two subsamples of 50 seeds of each plot were weighted and placed in plastic cups with 75 mL of distilled water for 24 h at 25 °C. The electrical conductivity was measured in a conductivity meter and the results were expressed as microsiemens per centimeter per grams (µS cm^{-1} g^{-1}) (Vieira & Krzyzanowski, 1999).

Tetrazolium test (T) was performed using two subsamples of 25 seeds per plot, accounting 150 seeds by treatment. The preconditioning of seeds was carried out on paper towers moistened with distilled water, and remained for 16 hours in germination chamber at 25 °C. Then, they were immersed in a chloride triphenyl tetrazolium solution (concentration of 0.075%) and replaced in the germination chamber for 3 hours. The seeds were then washed and maintained in distilled water. The evaluation was performed cutting the embryonic axis of the seeds half, according to the methodology proposed by Krzyzanowski et al. (1991).

The data were subjected to variance analyses using the statistical software Sisvar® (Ferreira, 2014) by the F test (p = 0.05), when pertinent, the mean values were compared using the Scott-Knott test at a probability of 5%, and Pearson's correlations were obtained among the tests results using Genes software (Cruz, 2013).

Results and Discussion

All factors (soybean cultivars, desiccants, and times of application), as well as the interactions between the pairs of factors and the triple interaction were statistically significant ($p < 0.05$) for seed yield, lignin content, germination test (G), accelerated aging test (AA), and emergence test (E). For the tests of tetrazolium (T) and electrical conductivity (EC), the factors soybean cultivars, desiccants, and the interaction soybean cultivars x desiccants were statistically significant, in addition to the interaction soybean cultivars x times of application in the tetrazolium test. Only the factor soybean cultivars and the interaction soybean cultivars x desiccants were statistically significant for the emergence speed index (ESI) test.

The means presented in Table 1 clearly show the interaction between the pairs of factors and the differential effect of the three factors in the lignin content, showing that the lignin content expressively varied among the cultivars, from 0.322 g% (BRS Silvânia RR) to 0.197 g% (BRS 247 RR).

In general, cultivars BRS Silvânia RR and BRS Valiosa RR showed higher lignin content (0.461 and 0.320 g%), while cultivars BRS 245 RR and BRS 247 RR showed lower levels (0.146 and 0.182 g%), agreeing with previous results reported by Menezes et al. (2009), Gris et al. (2010) and Dantas et al. (2012). Thus, in conformity with the initial purpose of this research, it was possible to divide cultivars in two groups, formed by the cultivars with high lignin content (BRS Silvânia RR and BRS Valiosa RR), and by the cultivars with low lignin content (BRS 245 RR and BRS 247 RR).

Several genes and enzymes participate in the processes of synthesis and accumulation of lignin in soybean seeds tegument (Menezes et al., 2009). The expression of this trait is highly influenced by genetic and environmental factors that may also affect seeds development and quality. According to Capeleti et al. (2005), seeds containing more than 0.4 g% of lignin in the tegument usually have more tolerance to mechanical damages, showing better physiological quality.

Seed yield ranged from 1726 kg ha^{-1} to 3927 kg ha^{-1}, the cultivars BRS Silvânia RR and BRS Valiosa RR had lower yield means, 2449 and 2808 kg ha^{-1}, respectively (Table 2). In general, Finale® was the herbicide that greatly affected the seed yield, especially when applied at the 3rd time.

In general, higher yield was observed when no herbicide was used (control treatment), that is, without desiccation. However, it is important to recall that, besides this agricultural practice, seed yield is highly influenced by multiple factors, as genotype and environmental conditions.

Cultivars showed similar results in the germination test (GT), wherein the cultivars with lower lignin content showed a slightly higher percentage of germination than the cultivars with higher lignin content (Table 3).

Studying the influence of lignin content in the quality and viability of soybean seeds after storing, Dantas et al. (2012) observed that cultivars with higher lignin content showed lower proportion of normal seedling. Oliveira et al. (2014) discuss that seeds with higher lignin content absorb less water, which is essential to the metabolic activities that occur during the germination process. In this study, the desiccant Finale®

Table 1. Lignin content (g%) in seeds of soybean cultivars desiccated with different herbicides at different times.

Time[1]	Desiccants	Soybean cultivars			
		BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
1st	Control	0.304 Ac[2]	0.293Aa	0.210 Bb	0.196 Ba
	Finale®	0.461 Aa	0.317 Ba	0.235 Cb	0.210 Ca
	Gramoxone®	0.238 Cd	0.320 Aa	0.265 Ba	0.182 Da
	Reglone®	0.378 Ab	0.251 Ba	0.230 Bb	0.198 Ca
2nd	Control	0.299 Ab	0.291Aa	0.221 Ba	0.194 Bb
	Finale®	0.272 Bb	0.306Aa	0.236 Ca	0.192 Db
	Gramoxone®	0.289 Ab	0.259 Bb	0.146 Cb	0.244 Ba
	Reglone®	0.359 Aa	0.260 Bb	0.227 Ba	0.188 Cb
3rd	Control	0.302 Aa	0.297Aa	0.219 Ba	0.192 Ba
	Finale®	0.338 Aa	0.302Aa	0.235 Ba	0.187 Ca
	Gramoxone®	0.308 Aa	0.241 Bb	0.193 Cb	0.201 Ca
	Reglone®	0.310 Aa	0.246 Bb	0.233 Ba	0.182 Ca
	Mean	0.322	0.282	0.221	0.197

[1]Times of application of desiccants: 1st time = 50% seeds water content, 2nd time = 40% seeds water content, and 3rd time = 30% seeds water content. [2]Means followed by the same uppercase letters in the rows and by the same lowercase letters in the columns belong to the same group by the Scott-Knott test at a probability of 5%.

Table 2. Seed yield (kg ha^{-1}) of soybean cultivars desiccated with different herbicides at different times.

Time[1]	Desiccants	Soybean cultivars			
		BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
1st	Control	2905 Ba[2]	3066 Ba	3673 Aa	3041 Ba
	Finale®	2283 Bb	2995 Aa	2724 Ac	3094 Aa
	Gramoxone®	2817 Ba	2822 Ba	3255 Ab	2651 Bb
	Reglone®	2797 Ba	2745 Ba	2738 Bc	3364 Aa
2nd	Control	2881 Ba	3016 Ba	3603 Aa	2983 Bb
	Finale®	1726 Bb	2940 Aa	2704 Ab	2536 Ac
	Gramoxone®	1908 Cb	1809 Cc	3051 Bb	3555 Aa
	Reglone®	2143 Db	2558 Cb	3040 Bb	3927 Aa
3rd	Control	2825 Ba	3102 Ba	3573 Aa	3106 Bb
	Finale®	2639 Aa	2467 Ab	2063 Bc	2601 Ac
	Gramoxone®	2385 Cb	3068 Ba	3026 Bb	3490 Aa
	Reglone®	2079 Bb	3106 Aa	3455 Aa	3362 Aa
	Mean	2449	2808	3075	3142

1/Times of application of desiccants: 1st time = 50% seeds water content, 2nd time = 40% seeds water content, and 3rd time = 30% seeds water content. 2/Means followed by the same uppercase letters in the rows and by the same lowercase letters in the columns belong to the same group by the Scott-Knott test at a probability of 5%.

Table 3. Percentage of seeds germination of soybean cultivars desiccated with different herbicides at different times.

Time[1]	Desiccants	Soybean cultivars			
		BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
1st	Control	97 Ba[2]	97 Ba	98 Aa	99 Aa
	Finale®	98 Aa	94 Bb	92 Cb	95 Bb
	Gramoxone®	98 Aa	95 Bb	98 Aa	99 Aa
	Reglone®	97 Ba	98 Ba	97 Ba	99 Aa
2nd	Control	96 Bb	97 Ba	99 Aa	99 Aa
	Finale®	99 Aa	98 Aa	99 Aa	96 Bb
	Gramoxone®	98 Aa	94 Bb	99 Aa	98 Aa
	Reglone®	96 Bb	96 Ba	99 Aa	100 Aa
3rd	Control	97 Bb	96 Bb	100 Aa	98 Aa
	Finale®	99 Aa	99 Aa	99 Aa	98 Aa
	Gramoxone®	94 Bd	95 Bc	99 Aa	99 Aa
	Reglone®	96 Cc	94 Cc	97 Bb	100 Aa

1/Times of application of desiccants: 1st time = 50% seeds water content, 2nd time = 40% seeds water content, and 3rd time = 30% seeds water content. 2/Means followed by the same uppercase letters in the rows and by the same lowercase letters in the columns belong to the same group by the Scott-Knott test at a probability of 5%.

applied at the first time harmed the seeds germination, especially in cultivars with low lignin content.

Finale® is a commercial formula for glufosinate ammonium that shows an easier translocation compared to paraquat and diquat (Lacerda et al., 2005). Since water is the principal transportation agent to intern tissues, the higher the water content in the seeds, the higher the possibility of damage is caused by the desiccants (Pereira et al., 2015). Therefore, the application of Finale® when seeds had 50% of water content may have favored the product translocation to the interior of the cells, causing some phytotoxic effect.

The electrical conductivity test showed that the use of desiccants was superior than the control treatment in cultivars with higher lignin content. The use of desiccants did not differ from the control for the cultivars with low lignin content. The seeds of BRS Valiosa RR showed higher vigor than the seeds of other cultivars when plants were desiccated (Table 4).

The high lignin content in seeds tegument make it difficult the process of water absorption and favor the loss of important substances, affecting the electrical conductivity values (Oliveira et al., 2014). In this study, seeds of the cultivar BRS Valiosa RR, which have high lignin content, showed greater vigor when the plants were desiccated.

The emergence test showed that the cultivar BRS Silvânia RR was the most affected when subjected to desiccation, especially using the herbicides Finale® and Gramoxone®. Finale® applied at the third time impaired the emergence of the seeds of cultivars BRS Silvânia RR and BRS Valiosa RR (Table 5). The results from emergence speed index showed that the cultivars with low lignin content (BRS 245 RR and BRS

Table 4. Electric conductivity (μS.cm^{-1}) of seeds of soybean cultivars desiccated with different herbicides at different times .

Desiccants	Soybean cultivars			
	BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
Control	73.52 Bc[1]	63.88 Bb	65.18 Ab	61.24 Aa
Finale®	67.44 Ac	57.95 Aa	67.07 Ac	62.15 Ab
Gramoxone®	68.86 Ac	59.54 Aa	67.88 Ac	63.39 Ab
Reglone®	68.92 Ab	59.53 Aa	67.56 Ab	62.23 Aa

1/Means followed by the same uppercase letters in the columns and by the same small letters in the rows belong to the same group by the Scott-Knott test at a probability of 5%.

Table 5. Percentage of seeds emergence of soybean cultivars desiccated with different herbicides at different times.

Time[1]	Desiccants	Soybean cultivars			
		BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
1st	Control	98 Aa[2]	97 Aa	97 Aa	99 Aa
	Finale®	97 Aa	95 Aa	89 Bb	97 Aa
	Gramoxone®	97 Aa	97 Aa	98 Aa	99 Aa
	Reglone®	98 Aa	97 Aa	99 Aa	98 Aa
2nd	Control	97 Aa	98 Aa	99 Aa	98 Aa
	Finale®	97 Aa	98 Aa	98 Aa	99 Aa
	Gramoxone®	98 Aa	98 Aa	98 Aa	99 Aa
	Reglone®	98 Aa	97 Aa	99 Aa	98 Aa
3rd	Control	98 Aa	96 Aa	99 Aa	100 Aa
	Finale®	96 Bb	96 Ba	99 Aa	99 Aa
	Gramoxone®	95 Bb	98 Aa	99 Aa	100 Aa
	Reglone®	99 Aa	96 Aa	98 Aa	98 Aa

[1/]Times of application of desiccants: 1st time = 50% seeds water content, 2nd time = 40% seeds water content, and 3rd time = 30% seeds water content. [2/]Means followed by the same uppercase letters in the columns and by the same lowercase letters in the rows belong to the same group by the Scott-Knott test at a probability of 5%.

247 RR) had higher vigor. The desiccation did not affect the seeds emergence of the cultivars BRS Valiosa RR and BRS 245 RR (Table 6).

The results of the emergence speed index test were similar to those obtained in the germination test. Menezes et al. (2009) also obtained similar results studying chemical and structural aspects of the physiological quality of seeds. According to the authors, the germination rate can be negatively correlated to the lignin content in soybean seeds.

Similar results were obtained by Inoue et al. (2003), in which the use of glufosinate provided higher percentage of normal seedlings at the artificial aging test. In this study, the desiccation performed at the first and second times led to a great reduction of seeds vigor, reaching 18% of reduction, as noted for BRS Silvânia RR when treated with Regalone®. This result may be related to the development stage and water content of the seeds.

The artificial aging test showed that the cultivars with higher lignin content (BRS Silvânia RR and BRS Valiosa RR) had the worst results for the control treatment. The cultivars with high lignin content showed better performance when the desiccation was performed, especially when Finale® was used. For the cultivars with low lignin, the application of Finale® reduced seeds vigor at the first time, and no statistical difference was observed between desiccation and control at the second and third times (Table 7).

The tetrazolium test also showed less seeds vigor of the cultivar BRS Silvânia RR, except when Regalone® was used. However, higher vigor was obtained when plants were desiccated, comparing to the control. No statistical difference

Table 6. Emergence speed index of seeds of soybean cultivars desiccated with different herbicides at different times.

Desiccants	Soybean cultivars			
	BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
Control	12.64 Bb[1]	12.52 Ab	14.60 Aa	14.02 Ba
Finale®	13.32 Ab	12.21 Ab	13.55 Aa	13.49 Ba
Gramoxone®	12.73 Bb	12.27 Ab	14.15 Aa	14.66 Aa
Reglone®	13.40 Ab	12.50 Ac	14.03 Aa	14.44 Aa

[1/]Means followed by the same uppercase letters in the columns and by the same lowercase letters in the rows belong to the same group by the Scott-Knott test at a probability of 5%.

Table 7. Percentage of seeds germination at the artificial aging test of soybean cultivars desiccated with different herbicides at different times.

Time[1]	Desiccants	Soybean cultivars			
		BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
1st	Control	75 Cb[2]	94 Ba	99 Aa	98 Aa
	Finale®	86 Ca	96 Aa	91 Bb	93 Bb
	Gramoxone®	86 Ba	97 Aa	98 Aa	97 Aa
	Reglone®	76 Bb	95 Aa	97 Aa	96 Aa
2nd	Control	79 Cc	93 Bb	98 Aa	96 Aa
	Finale®	95 Aa	98 Aa	97 Aa	98 Aa
	Gramoxone®	85 Bb	96 Aa	99 Aa	98 Aa
	Reglone®	92 Ba	99 Aa	99 Aa	97 Aa
3rd	Control	77 Cd	92 Bb	98 Aa	97 Aa
	Finale®	85 Bb	97 Aa	98 Aa	97 Aa
	Gramoxone®	91 Ba	97 Aa	99 Aa	99 Aa
	Reglone®	81 Bc	97 Aa	99 Aa	100 Aa

[1/]Times of application of desiccants: 1st time = 50% seeds water content, 2nd time = 40% seeds water content, and 3rd time = 30% seeds water content. [2/]Means followed by the same uppercase letters in the rows and by the same lowercase letters in the columns belong to the same group by the Scott-Knott test at a probability of 5%.

Table 8. Percentage of vigor in the tetrazolium test of seeds of soybean cultivars desiccated with different herbicides at different times.

Desiccants	Soybean cultivars			
	BRS Silvânia RR	BRS Valiosa RR	BRS 245 RR	BRS 247 RR
Control	95 Cb[1]	98 Aa	99 Aa	99 Aa
Finale®	97 Bc	98 Ab	100 Aa	99 Bb
Gramoxone®	99 Ab	99 Ab	100 Aa	100 Aa
Reglone®	98 Aa	98 Aa	100 Aa	99 Ba

[1/]Means followed by the uppercase letters in the columns and by the same lowercase letters in the rows belong to the same group by the Scott-Knott test at a probability of 5%.

Table 9. Pearson's correlation among the results of the germination test (G), artificial aging test (AA), electrical conductivity test (EC), emergence speed index (ESI), emergence test (E), tetrazolium test (T), and the traits seed yield (SY) and lignin content (LC) in seeds of soybean cultivars desiccated before harvesting.

	GT	AA	CE	ESI	E	T	SY	LC
GT	1	0.2672	0.2775	1.0092	0.9813	0.5413	0.6111	-0.7533
AA		1	-0.6933	0.4014	0.3424	0.9609	0.9319	-0.8305
CE			1	0.2134	-0.0529	-0.4347	-0.5025	0.3969
ESI				1	0.9055	0.6733	0.7117	-0.819
E					1	0.5292	0.6911	-0.8451
T						1	0.9949	-0.9371
SY							1	-0.9847

was observed among the herbicides for cultivars BRS Valiosa RR and BRS 245 RR. For the seeds of the cultivar BRS 246 RR, Gramoxone® and the control treatment provided better results on tetrazolium test than Regalone® and Finale® (Table 8).

Choosing the formulation and the time of application depends on how the desiccant acts and on the weather conditions during and after the application. When the seeds water content was around 50%, performing the desiccation did not damage the seeds quality. In general, the glufosinate ammonium affected negatively the seeds quality, agreeing with previous studies using this formulation.

Besides adopting agricultural practices to guarantee seeds quality, genetic breeding is also a very important tool to achieve this goal. Breeding programs usually consider the seeds quality during selection, and one way to do that is measuring the lignin content present in the seeds tegument. Studies affirm that the lignin content has a direct relation with the seeds resistance to mechanical damage. Some researchers believe that this trait also has a relation with physiological and sanitary quality of the seeds, since the features of their tegument influences the exchanges between the seeds and the environment.

Genetic soybean breeding programs have currently selected genotypes with lignin content above 0.4g%, in order to indirectly select seeds with physiological quality. However, previous studies indicated negative correlation between the content of lignin in the tegument and the seeds quality. In this study, the lignin content showed high negative correlation with all the traits, except with electrical conductivity, emphasizing the correlation with seed yield (r = -0.98) and with seeds vigor at the tetrazolium test (r = -0.93) (Table 9).

The genotypes evaluated in this study were chosen taking into account the discrepancy in the lignin content in the seed tegument, reported in previous researches and also by their companies holders. It was possible to observe that the difference of lignin content among the genotypes was not as large as expected, possibly due to environmental conditions and to agricultural practices during the seeds production. This result shows the difficulty considering the lignin content as a major trait to indirectly select genotypes with better seeds quality Thus, more studies on the genetic relationship among the traits and of the enzymatic process involved on tegument lignification are needed to elucidate the main factors related to the effect of the lignin content in the physiological and sanitary quality of soybean seeds.

Conclusions

There is a relation between lignin content in the tegument and the physiological quality of soybean seeds.

Cultivars with lower lignin content in the tegument have higher seed physiological quality and seed yield.

The plants desiccation with the herbicide Finale® affected negatively the cultivars seed quality.

Acknowledgment

The authors thank the funding institutions "Conselho Nacional de Desenvolvimento Científico e Tecnológico" (CNPq) and "Coordenação de Aperfeiçoamento de Pessoal de Nível Superior" (CAPES).

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