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Physiological potential of soybean seed and your relationship with seedling emergence in the field

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ABSTRACT- The objective of this study was to evaluate soybean seed vigour and verify seedling emergence in the field. The tests for soybean seed vigour in the three cultivars were seedling field emergence, germination, seedling emergence in sand substrate, tetrazolium and electrical conductivity. There was no difference in germination and vigour between studied varieties. The determining factor in the experiment was time of planting, in which the lowest germination index occurred during the dry season.
Key words: Correlation, Germination, *Glycine max*, Vigour

Introduction

Physiological quality is the ability to perform vital functions, characterised by germination, vigour and longevity. These characteristics are important as they directly affect crop sowing under field conditions (POPINIGIS, 1977).

Seed vigour determines the potential for rapid and uniform seed emergence and normal seedling development in the field (MCDONALD JÚNIOR, 1980).

The germination test is widely used to evaluate the quality of different seed lots. It is important to analyse germination under field conditions as humidity, temperature and aeration in the laboratory are all controlled, resulting in high percentages of germination (SCHUAB et al., 2006).

Seed deterioration is a characteristic of reduction in germination potential that occurs during storage, and is verified by a decrease in germination percentage or increase in the incidence of seedling abnormalities, indicating a reduction in seed vigour (DELOUCHE, 2002).

When compared to the germination test, seed vigour tests provide a higher sensitivity index of physiological potential (Association of Official Seed Analysts, 1983). Seeds with high vigour are expected to perform better in the field, especially in the seedling phase, which utilises the reverse of the seed for its growth (CARVALHO, 1994).

In view of the above, the aim of this study was to evaluate soybean seed vigour and verify seedling field emergence.

Methods

This study was conducted at the Agro North Research and Seeds' (Agro Norte Pesquisa e Sementes) Laboratory of Seed Analysis (Laboratório de análise de Sementes), located in the municipality of Sinop-MT. Three seed lots represented by the following soybean cultivars were used: ANsc83 022, ANrr85 509 and ANsc89 109. These lots were obtained from the company's Seed Production System collected in the 2015/2015 agricultural year.

Physiological quality of the different seed cultivars was evaluated through the following tests:

1) Seedling field emergence: This test was performed using four subsamples of 100 seeds for each treatment, distributed in furrows 1.0 m in length. Sowing depth was approximately 3.0 cm with 0.5 m line spacing. The minimum and maximum temperature, rainfall and relative humidity during the testing period are presented in Table 1. Relative humidity is presented as the daily average obtained from readings taken at 2 hour intervals. The percentage of normal seedlings was evaluated nine days after initial sowing.

Table 1. Minimum and maximum temperature, rainfall and relative humidity. Sinop, MT, 2015.

	Minimum Temperature (°C)	Maximum Temperature (°C)	Rainfall (mm)	Relative humidity (%)
24/10/2015	21.2	32.3	0.00	70.3
31/10/2015	25.7	39.0	20.0	68.3
03/11/2015	23.5	29.9	42.0	85.9
07/11/2015	25.3	36.1	0.00	66.4
10/11/2015	24.4	35.0	57.5	69.0
16/11/2015	24.4	34.0	32.0	69.8

2) Germination test: This test was performed using four subsamples of 50 seeds for each replicate and treatment. The seeds were sown in germ paper with an amount of distilled water equivalent to two and a half times the mass of the dry paper.

Rolls were formed and placed into a germinator at a constant 25°C. The number of normal seedlings was evaluated five and eight days after sowing, thus expressing the values referring to the vigour and germination of the lots, respectively. The results were presented as percentage of normal seedlings, according to requirements contained in the Rules for Seed Analysis (Regras para Análise de Sementes) (BRASIL, 1992).

3) Seedling emergence: Seedling emergence in sand substrate was conducted with 4 subsamples of 100 seeds for each replicate. The sand used in this study was previously washed and sieved. A mixture of 50% sand and 50% virgin land (removed from the middle of the forest without organic residues and sieved) was placed in beds and irrigated for two consecutive days for bedding. At the time of sowing holes were made using a wooden template containing 100 tips 3 cm long spaced 2 cm apart.

Testing was performed under greenhouse conditions, maintaining humidity with moderate irrigation during the same period in which laboratory testing was conducted.

The number of emerged seedlings was counted on the fifth and ninth day after sowing.

At the end of the ninth day from the initial sowing event, the percentage of normal seedlings was evaluated according to requirements in the Rules for Seed Analysis (Regras para Análise de Sementes) (BRASIL, 1992).

4) Tetrazolium test: The tetrazolium test was conducted with 4 subsamples of 50 seeds for each treatment. These were preconditioned by being moistened on germ paper with distilled water for 16 hours in a germinator at 25°C. After this period the seeds were transferred to plastic cups and immersed in tetrazolium solution (0.075%) for 3 hours in a dark incubator at 40°C. After the staining process, the seeds were washed and classified into vigour and viability levels ranked from 1 to 8 according to criteria proposed by França Neto et al. (1998). Potential vigour and germination were expressed as a percentage (França Neto et al., 1999).

5) Electrical conductivity: Electrical conductivity was tested using 4 subsamples of 50 seeds for each treatment. Initially, the seeds were placed into plastic cups and weighed using an analytical balance with 0.001 g accuracy. After weighing, 75 mL of distilled and deionised water was added to the cups containing seeds and then placed into a germination chamber at 25°C for 24 hours (Loeffler et al., 1988).

Seed moisture content was previously determined by the oven method at 105 ± 3°C for 24 hours (BRASIL, 1992), using two replicates of 10 g (Table 2).

Table 2. Mean values of initial seed moisture in the three soybean cultivars before undergoing the electrical conductivity test. Sinop, MT, 2015.

Variety	Moisture Content
89 109	10.01 %
83 022	9.75 %
85 509	10.11 %

Electrical conductivity reading in the soaking solution was subsequently performed using a Geharka brand GC 1400 conductivity meter. The value indicated by the meter was recorded and divided by the weight obtained from each sub-sample. Thus, the result obtained was expressed in $\mu S.cm^{-1}\ g^{-1}$ (VIEIRA & KRZYZANOWSKI, 1999).

In order to avoid the effect of water content on conductivity results, the correction factor was determined for the standard value, for example 13% moisture (LOEFFLER et al., 1988; CARVALHO, 1994), using the equation proposed by Penariol (1997). Using the correction factor, Carvalho (1994) obtained the same electrical conductivity standard for soybean seed lots, with a water content ranging from 7% to 14.5%. Similar results were obtained by Penariol (1997), using equation 1.

$$CE = [0.3227 + 0.05115 * (TA)] * CE^0$$

Where:
CE = corrected electrical conductivity, TA = seed water content and CE^0 = observed electrical conductivity.

Corrected conductivity was obtained by inserting the seed moisture content values from Table 2 into equation 1.

Statistical analyses were performed using a completely randomized design for the tests, and a factorial treatment structure with a 5% probability significance level in the analysis of planting times. A Tukey's test was used to compare the means of soybean germination in the field experiment using three varieties across three planting times.

Results and discussion

Data from the field experiment using three varieties of soybean seed across three planting times is presented in Table 3.

Table 3. First and last counts from the field experiment using three varieties of soybean seed across three planting times. Sinop, MT, 2015.

	Field Test 1st planting event 24/10		Field Test 2nd planting event 31/10		Field Test 3rd planting event 07/11	
Variety	1st Count	Final count	1st Count	Final count	1st Count	Final count
83 022	0	76	82	87	87	88
85 509	0	72	81	85	94	94
89 109	0	73	79	83	88	88

Seedlings from the field experiment's 1st planting event (Table 3) were not present during the first count. This is likely due to the fact that the seeds were sown in extremely dry soil and the first recorded rainfall occurring only during the time of the final count. Due to this occurrence the final count was not performed after 8 days as indicated, but after 10 days, in order to demonstrate the necessity of ideal amounts of water for initiation of the germination stage.

According to Merotto Júnior (1999), seeds that delay germination through intrinsic or extrinsic factors may present lower shoot and root system growth, thereby decreasing their capacity to compete for water, light and nutrients.

It is clear that within this region rainfall is essential at the time of planting in order to facilitate a higher germination index.

Table 4 below shows the mean seed germination of the three soybean seed varieties used across three planting times in the field experiment.

From the results obtained in the field and presented in Table 4 above, there was no difference between the cultivars studied. There was a difference between planting events in the field experiment as the number of seedlings in planting event 1 were lower than in planting events 2 and 3. This was principally due to weather, as the seeds were planted in dry soil conditions with zero rainfall.

In order to evaluate seed germination potential a comparison between the vigour (germination) tests most used was performed.

In Table 5 below mean germination for the three varieties is presented for the standard germination and seedbed tests

Table 4. Means of soybean seed germination for the three varieties used in the field experiment across three planting times. Sinop, MT, 2015.

	Planting event			
Variety	1	2	3	Total
83 022	76	87	88	83 A
85 509	72	85	94	83 A
89 109	73	83	88	81 A
Total	74 b	85 a	90 a	
C.V.	6.50 %			

Means in the column followed by a capital letter and in the row with the equal lower case letter do not differ from each other by way of a Tukey test at 5% probability.

A separate analysis of the standard germination and seedbed tests for seed germination revealed no significant difference between means of the three varieties studied at a 5% significance level.

However, the seedbed test resulted in a higher number of germinated seeds compared to the standard germination test.

Table 5. Mean germination of soybean seeds at the 1st and final counts for the three varieties analysed. Sinop, MT, 2015.

Variety	Standard test		Seedbed test		
	First count	Final count	First count	Final count	
83 022	61	79	88	95	p>0,05
85 509	68	88	91	95	p>0,05
89 109	64	82	87	95	p>0,05

We observed that the number of seeds germinated in the 1st count was lower, and for the standard test the difference between the 1st and final count was higher than in the seedbed test.

Braccini et al. (1994) verified that the seedbed emergence test overestimated the physiological quality of evaluated soybean seeds, and also presented higher values than those obtained with the standard germination test, in agreement with this study.

Table 6 shows the results of the tetrazolium test for the studied varieties.

Table 6. Tetrazolium test for the three varieties studied. Sinop, MT, 2015.

Variety	Tetrazolium	
	1-3	1-5
83 022	96	96
85 509	94	96
89 109	95	96

The results in Table 6 show very high vigour (greater than 85%) for the three varieties studied with the tetrazolium test (1-3), and that there was no difference between varieties. Potential viability evaluation of seeds in the tetrazolium test (1-5) did not distinguish between cultivars in relation to higher seed quality in agreement with the results found by Schuab et al. (2006).

Electrical conductivity (EC) for the varieties studied with corrected values for ideal moisture by equation 1 is presented in Table 7.

Table 7. Electrical conductivity of the three soybean varieties studied. Sinop, MT, 2015.

Variety	Electrical conductivity μS.cm^{-1} g^{-1}
83 022	62.44
85 509	68.46
89 109	71.08

The electrical conductivity test showed sensitivity in differentiating physiological potential of the evaluated genotypes (Kulik & Yaklic, 1982). However, as verified with seedling field emergence, germination and vigour tests, there was no significant difference between varieties at a 5% significance level, supporting the results found by Marcos Filho et al. (1984).

PRADO, J.P. et al. (2015) described that electrical conductivity values below 140.00 μS.cm-1 g-1 correspond to field emergence values higher than 80%, supporting the results found in the present study for all tests performed, with the exception of the first planting event for the field test due to strong climatic interference.

In this study, the Pearson correlation coefficient was also determined for data obtained in the tests. Table 8 presents the means for the tests carried out and Table 9 shows the correlation coefficients (r) estimated between germination and seed vigour tests and seedling germination in the field, obtained with the mean of the three cultivars studied.

According to Marcos Filho et al. (1984), using correlation to compare laboratory test results with field germination values may lead to misinterpretation of the data, therefore the use of correlation as an exclusive analysis is considered to be inappropriate. It can be seen in Table 8 that the correlation coefficient results found in this study supports those of Marcos Filho et al. (1984).

It can be observed that the tetrazolium test (1-3) and (1-5), as well as the standard germination test showed strong correlation with field results (final count) for the first and third planting events. Electrical conductivity (EC) showed strong correlation with the field test in the second planting event.

Table 8. Means of the three cultivars studied for the tests performed. Sinop, MT, 2015.

Standard germination Final Count	Seedbed Final Count	Field 1st event Final Count	Field 2nd event Final Count	Field 3rd event Final Count	Tetrazolium (1-3)	Tetrazolium (1-5)
83	95	74	85	90	95	96

Table 9. Correlation coefficients (r) estimated between germination and seed vigour tests and germination of field seedlings, obtained with the mean of the three cultivars studied. Sinop, MT, 2015.

	Seedbed test Final count	Field test 1st event Final count	Field test 2nd event Final count	Field test 3rd event Final count
Electrical conductivity	-0.728	-0.765	-0.998	0.195
Tetrazolium (1-5)	0.500	-0.803	-0.163	0.999
Standard germination test final	0.254	-0.932	-0.417	0.955

Conclusions

The varieties ANsc83 022, ANrr85 509 and ANsc89 109 possess similar physiological potential.

Rainfall was the determining factor and influenced seedling germination in the field. Under dry conditions, seeds were slow to germinate and presented a lower germination percentage compared to planting carried out when rainfall had already occurred at the production area.

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