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ARTICLE

The Vigor-S system as an auxiliary component of the accelerated aging test procedure in soybean seeds

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ABSTRACT: Computerized seedling image analysis is available as a resource for evaluating seed vigor or as an auxiliary component while carrying out different tests. The aim of this study was to evaluate the efficiency of the Vigor-S system for interpretation of the accelerated aging test, rather than setting up the germination test for determination of soybean seed vigor. Nine seed lots of the soybean cultivar NS 7007 IPRO were used, which were tested for germination and vigor (electrical conductivity, accelerated aging, primary root emergence, seedling emergence in the field, and Vigor-S). To check the alternative procedure after accelerated aging, seeds that had been exposed to accelerated aging (the traditional procedure and with saturated salt solution) were placed to germinate; seedling images collected three days after germination at 25 °C were digitalized and analyzed by Vigor-S, obtaining vigor indices, hypocotyl length, primary root length, and total seedling length, which were subsequently compared with the results of the other vigor tests. The Vigor-S analyses made after both procedures of the accelerated aging test allow ranking of the seed lots in regard to vigor, in a way similar to the other tests recommended for soybean seeds, including the seedling emergence test.

Index terms: digital image, *Glycine max* (L.) Merrill, physiological potential.

RESUMO: A análise computadorizada de imagens de plântulas é um recurso disponível para avaliar o vigor de sementes ou constituir componente auxiliar durante a condução de diferentes testes. O objetivo desta pesquisa foi avaliar a eficiência do sistema Vigor-S para a interpretação do teste de envelhecimento acelerado, como alternativa à instalação do teste de germinação, na determinação do vigor de sementes de soja. Utilizaram-se nove lotes de sementes do cultivar NS 7007 IPRO, submetidos a testes de germinação e de vigor (condutividade elétrica, envelhecimento acelerado, emergência da raiz primária, emergência de plântulas em campo e Vigor-S). Para verificar a alternativa do procedimento após o envelhecimento acelerado, plântulas coletadas após três dias de germinação a 25 °C, após a exposição das sementes ao envelhecimento acelerado (procedimento tradicional e com solução saturada de NaCl), foram digitalizadas e analisadas pelo Vigor-S, obtendo-se índices de vigor, comprimento do hipocótilo, da raiz primária e total da plântula, posteriormente comparados com os resultados dos demais testes de vigor. As análises Vigor-S efetuadas após ambos os procedimentos do teste de envelhecimento acelerado permitem o ranqueamento de lotes de sementes quanto ao vigor, de maneira semelhante a outros testes recomendados para sementes de soja, inclusive a emergência de plântulas.

Termos para indexação: imagem digital, *Glycine max* (L.) Merrill, potencial fisiológico.

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INTRODUCTION

Evaluation of the physiological potential of soybean seeds is fundamental in quality control programs conducted by soybean seed production companies. Although results of vigor tests are not components of the standards established for the domestic or international seed trade, they are very important for estimating the performance of seed lots during storage and after sowing in the field. This is due to their ability to detect relatively small variations in the stage of deterioration of seed lots with similar germination rates (Baalbaki et al., 2009).

Internal quality control programs seek to evaluate seed physiological potential based on combined interpretation of the results of different tests, the principles of which are directly related to the intended goals (TeKrony, 2003). Therefore, the main strategy of more experienced seed producers has been to use vigor tests with sufficient sensitivity to detect strengths and weaknesses during the different steps of post-maturity seed management practices and to enable commercialization of seed lots with greater possibility of exhibiting good performance in the field (Marcos-Filho, 2015).

Quality control for soybean seeds is increasingly efficient and dynamic, mainly as a result of market competitiveness, leading to growth in investments in this area. Various tests have been recommended for evaluation of soybean seed vigor, most prominently the tetrazolium test, electrical conductivity test, and accelerated aging test, all of which have been validated by the International Seed Testing Association for soybean seeds (ISTA, 2022), as well as evaluation of seedling growth (Krzyzanowski et al., 2020). One of the main objectives of vigor tests is complementing the information provided by the germination test, allowing identification of differences in seed lot performance under wide variations of environmental conditions.

Accelerated aging is one of the most widely used vigor tests for seed vigor evaluation for various crop species. The test is used throughout the world in the composition of quality control programs established by the seed industry, especially for evaluation of the physiological potential of major field crop and vegetable seeds (Marcos-Filho, 2020).

In the accelerated aging test, the seeds are exposed for short periods to two environmental variables, high temperature and high relative humidity, which cause rapid deterioration of the seeds. Lots with high vigor seeds bear up better under these extreme stress conditions, deteriorate more slowly, and have higher germination after aging compared to low vigor seed lots (Baalbaki et al., 2009). The accelerated aging test provides valuable information regarding vigor differences among the samples analyzed, their storage potential, and seedling emergence in the field (Marcos-Filho, 2020); it has proven to be an efficient test in comparison with use of both the traditional procedure and the procedure involving the saturated salt solution (Pinto et al., 2018).

It is noteworthy that as knowledge has evolved, the possibility has arisen of adding computer resources to refine procedures, stimulating the development of specific systems for evaluation of different seed quality properties, including vigor (Marcos-Filho, 2016). The first consistent attempt to use computerized image analysis for determination of seed vigor was made by McCormac et al. (1990), who evaluated the primary root length of carrot and lettuce seedlings, followed by Howarth and Stanwood (1993), who evaluated lettuce and sorghum. After that, Sako et al. (2001) developed an automatic system to determine lettuce seed vigor, the Seed Vigor Imaging System (SVIS®), also considered efficient for various other species. More recently, the Seed Vigor Automated Analysis System (Vigor-S) was created, based on a principle similar to the SVIS®, but including new options to allow more objective and efficient evaluation of the physiological potential of seed lots.

The efficiency of Vigor-S was confirmed for estimating seed vigor in maize (Castan et al., 2018), common bean (Medeiros et al., 2019), cowpea (Rego et al., 2021), melon (Leite et al., 2020), and soybean (Rodrigues et al., 2020). It should be emphasized that the potential use of computerized image analysis of seedlings is not restricted to direct determination of vigor; there is also the possibility of acting as a complement to other tests, such as the accelerated aging test, controlled deterioration test, and cold test. Marcos-Filho et al. (2009) and Yagushi et al. (2014) observed the sensitivity of computerized image analysis (SVIS®) after the accelerated aging test with saturated salt solution for determination of soybean seed vigor. This sensitivity was likewise found for maize by Dias et al. (2015), and by

Leite et al. (2020) for melon. In addition, Ermis et al. (2015) found that evaluation of primary root emergence after the controlled deterioration test, instead of the counting of normal seedlings, can more rapidly provide results for evaluation of tomato seed vigor.

Thus, the use of computerized resources for analyzing seed and seedling images constitutes an alternative to reduce subjectivity and increase the speed and efficiency of evaluation of seed physiological potential. These are advantages that increase the reliability of the information obtained. In this context, this study was conducted with the aim of evaluating the efficiency of the Seed Vigor Automated Analysis System (Vigor-S) as an auxiliary component of the accelerated aging test, and the aim of comparing the information obtained with the information provided by tests already commonly used for determination of soybean seed vigor.

MATERIAL AND METHODS

Nine seed lots of the soybean cultivar NS 7007 IPRO of similar germination percentages but with differences in vigor were used. Initially, seeds from each lot were classified by differences in thickness (Vaughan et al., 1968) using a set of perforated metal screens with oblong openings with variations of 0.4 mm (1/64’’) in screen opening widths. Seeds of each lot held in the 14 × 3/4” ± 1/64” (6.35 ± 0.4 mm) screen, i.e., those representing medium seed size (Pinto et al., 2018), were collected and tested in different manners. Three evaluation times, at approximately three-month intervals, were used in this study to check the consistency of results. During this period, the seed samples were kept in a dry cold chamber (10 °C and 35% RH) to prevent rapid deterioration. The following evaluations were performed in the laboratory on the samples from each seed lot:

Seed water content: was determined by the laboratory oven method at 105 ± 3 °C for 24 h (Brasil, 2009) on two 5-g subsamples of seeds from each lot. Results were expressed as mean percentage (fresh weight basis) for each lot. Seed water content was also determined after seeds were exposed to the accelerated aging tests.

Germination: it was evaluated in four replications of 50 seeds each in rolls of paper towel moistened with water in an amount equivalent to 2.5 times the weight of the dry paper, at 25 °C. The evaluations were carried out at four days (first germination count) and at seven days after sowing; the tests were interpreted according to the Rules for Seed Testing (Brasil, 2009).

Accelerated aging: plastic boxes (11 cm × 11 cm × 3.5 cm) were used as individual compartments. The relative humidity within these boxes resulted from adding 40 mL of water (environment with approximately 100% RH) or saturated sodium chloride solution at the bottom of each box (Marcos-Filho, 2020). Samples of each seed lot were distributed so as to constitute a single layer covering the entire surface of the metallic screen suspended within each box. Accelerated aging was conducted at 41 °C for 48 h (traditional accelerated aging – TAA) or 72 h (saturated salt accelerated aging – SSAA) in a water-jacketed chamber. In both situations, the accelerated aging stress conditions were followed by the germination test at 25 °C for four days, as described above. Results of both tests were expressed as mean percentage of normal seedlings for each lot.

Electrical conductivity: four replications of 50 seeds were used for each lot, weighed (0.01 g), and placed in plastic cups with 75 mL of deionized water. These samples were kept in a germination chamber for 24 h at 25 °C, and then the electrical conductivity of the solution was determined using a Digimed conductivity meter, model DM-32. Data were expressed as $\mu S.cm^{-1}.g^{-1}$ of seeds (Vieira and Marcos-Filho, 2020).

Tetrazolium: three subsamples of 50 seeds each were used for each lot. Seeds were pre-conditioned between sheets of moistened paper towel and then kept in a germinator at 25 °C for 16 h. After that, the samples were placed in plastic cups containing 50 mL of a solution of 2,3,5 triphenyl tetrazolium chloride at 0.075% and kept in a laboratory oven at 40 °C for three hours for staining development. Seed vigor was interpreted based on seed classification according to França-Neto and Krzyzanowski (2020); the percentage of seeds included in classes 1 to 3 was considered and results were expressed as mean percentage of viable seeds for each lot.

Primary root emergence: five samples of 20 seeds each for each lot were distributed on two sheets of paper towel and covered with another, and all were moistened with water in the amount of 2.5 times the weight of the dry paper. Samples were germinated at 30 ± 1 °C for 24 h. Seedlings with a primary root of at least 1.0 mm were counted, and results were expressed as mean percentage for each lot.

Computerized seedling image analysis (Vigor-S): five replications of 20 seeds each per lot were distributed on two sheets of moistened paper towel (two rows of 10 seeds each) and covered with a third sheet; the rolls were kept in a germinator at 25 °C for three days. Next, the seedlings from each replication were transferred from the paper towel to a blue colored sheet of EVA (ethylene vinyl acetate), with dimensions of 30 cm × 22 cm (corresponding to the size of the effective area of the scanner), and then the seedling images were digitalized using a HP Scanjet 200 scanner set up in an inverted position within an aluminum box (60 × 50 × 12 cm), adjusted to a resolution of 300 dpi, and connected to a Core i7 computer (3.50 GHz and 16 GB of RAM). The images were processed by the Vigor-S software, which records the vigor index as well as the mean length of the hypocotyl and the primary root and the total length of the seedlings (Rodrigues et al., 2020). In those evaluations, the contribution of the growth value in computing the vigor index was 70% and that of the uniformity value was 30%. Furthermore, for the Vigor-S system, the contribution of the hypocotyl value to the calculation of seedling growth was 10% and that of the primary root was 90%.

Seedling emergence in the field: four replications of 50 seeds each were used, distributed at equal distance in furrows of 4 m length and 7 cm depth at a spacing of 40 cm between rows. The area was irrigated as necessary to ensure adequate emergence of the seedlings. The number of emerged seedlings was recorded daily to determine the emergence speed index (Maguire, 1962). The seedlings that reached the VC stage (expanded cotyledons, unifoliate leaves with the edges no longer touching) according to Costa and Marchezan (1982) were counted. At approximately 15 days after sowing, the percentage of seedling emergence was calculated to obtain the mean values per lot.

Vigor-S after accelerated aging: four replications of 25 seeds each from each lot that underwent TAA and SSAA under the conditions already described were germinated as indicated above, and then the seedlings were analyzed by the Vigor-S software. The seed lot ranking with respect to the vigor index and the hypocotyl, primary root, and total seedling lengths from the computerized analyses were compared with the results of the other vigor tests conventionally used for soybean seed evaluation. Figure 1 illustrates 3-day old seedlings from the germination, TAA, and SSAA tests.

Statistical analysis: analyses were performed separately for each seed test. Treatments (seed lots) were distributed in a completely randomized design, except for seedling emergence (randomized blocks), and analyzed to test the effects of seed lots and evaluation times. The Shapiro-Wilk test was first performed on the data and, when necessary, they were transformed in arc sen $(x/100)^{1/2}$ or $(x + 0.5)^{1/2}$. Statistical analysis was performed using the Sisvar software, and the mean values were compared by the Scott-Knott test ($P \leq 0.05$ error level).

Figure 1. 3-day old soybean seedlings from a single lot, cultivar NS 7007, collected after germination (A), traditional accelerated aging (B), and saturated salt accelerated aging (C).

RESULTS AND DISCUSSION

Analysis of variance indicated significant effects of the seed lots in all the tests conducted; but there were no effects from the evaluation times, indicating the absence of marked variations in the degree of deterioration of the seed lots over the experimental period and the reproducibility of the information generated in this study. The tests were sensitive to vigor differences among the lots, but they generally did not consistently discriminate the poorest performing lots. This result was not surprising, because the differences in initial physiological potential were quite small, as can be observed in the results of germination testing (variation from 91% to 97% among the lots). This truly accentuates the difficulty of separating the seed lots into different performance levels.

The results obtained in the germination test identified the statistical superiority of lots A1, A2, A3, and A6 in relation to the other lots, which did not differ significantly from each other (Table 1). It is noteworthy that all the lots exceeded the minimum germination established for commercial trade of soybean seeds (≥ 80%). This is important, since it would not be meaningful to evaluate the vigor of seeds with substandard germination, that is, seeds classified as grain but not certified for sowing in commercial crop fields.

The germination of lots A7, A8, and A9, along with that of lots A4 and A5, was significantly lower than that of the others ($P \leq 0.05$), based on the Scott-Knott test. The lower physiological potential of the seeds of these three lots was also detected by the electrical conductivity test. In this test and in the seedling emergence tests, marked differences were not identified among the less vigorous lots (A4 to A9) (Table 1).

In contrast, the greater vigor of lots A1, A2, and A3 was detected in all the vigor and seedling emergence tests (Table 1). Therefore, the traditional accelerated aging test and the test with saturated salt solution, electrical conductivity, the tetrazolium test evaluation of vigor, and the percentage and speed of seedling emergence in the field produced similar information on differences among lots regarding higher and lower vigor. This result shows that one of the basic objectives of inclusion of vigor tests in quality control programs has been fulfilled.

The seed moisture content before carrying out the tests ranged from 5.8% to 6.5%. After traditional accelerated aging, it ranged from 23.8% to 25.5%, and after the saturated salt solution test, from 11.7% to 12.3%. After the accelerated aging test with saturated salt solution, the results of moisture content exhibited smaller variation

Table 1. Germination (G), traditional accelerated aging (TAA), saturated salt accelerated aging (SSAA), primary root emergence (RE), electrical conductivity (EC), tetrazolium vigor (TZ), and percentage of seedling emergence (EM) and speed of seedling emergence (SSE) in the field in nine soybean seed lots, cultivar NS 7007 IPRO. Means of three evaluation times.

Lot	G[1]	TAA	SSAA	RE	EC	TZ	EM	SSE
	----------------- % -------------------				μS.cm^{-1}.g^{-1}	--------- % --------		index
A1	97 a	85 a	96 a	81 a	81.2 a	93 a	92 a	10.1 a
A2	96 a	86 a	96 a	74 a	72.7 a	94 a	93 a	9.0 a
A3	99 a	82 a	97 a	77 a	74.1 a	92 a	96 a	10.7 a
A4	91 b	42 b	85 d	54 b	130.7 c	86 b	66 b	6.1 b
A5	91 b	24 c	84 d	64 b	128.2 c	80 c	62 b	5.5 b
A6	97 a	24 c	92 b	79 a	115.0 b	85 b	66 b	5.6 b
A7	94 b	18 c	89 c	61 b	133.6 c	84 b	64 b	5.3 b
A8	93 b	15 d	84 d	45 b	132.9 c	82 c	55 b	4.8 b
A9	91 b	7 e	90 c	63 b	129.6 c	79 c	66 b	5.4 b

(1) Mean comparison within each column (Scott-Knott test, $P \leq 0.05$).

among the samples, indicating greater consistency of results. Uniform moisture content of the seeds before evaluation of physiological potential is indispensable for standardization of procedures and obtaining reliable results. Moisture content should be determined before and after the period of accelerated aging, so as to check the accuracy of the results. Marked differences can have a negative effect on the intensity of seed deterioration during aging. Therefore, to ensure consistency of the results, variations among the samples should not exceed 2.0 to 3.0 percentage points before and after aging (Marcos-Filho, 2020). This tolerance limit was not exceeded, and so differences in moisture content were not a factor that affected the performance of seed lots during the germination and vigor evaluations.

In spite of similar results regarding separation of the lots, the reduction in seed vigor brought about by the conditions of the traditional accelerated aging test was greater than in accelerated aging with the saturated salt solution. This is normal and occurs because the relative humidity within the plastic boxes with the saturated salt solution (76%) is lower than that maintained in the traditional test (near 100%); that allows standardization of and reduction in the speed of water absorption by the seeds, the intensity of deterioration, and the degree of stress placed on the seeds. At the same time, the fact that the traditional test showed greater sensitivity in detecting differences in the performance of lower vigor seed lots (A4 to A9) is probably related to the excessive deterioration brought about by the temperature and relative humidity conditions during the test. This is of less importance when, in parallel fashion, it is not detected by the other tests and, especially, it is not associated with the ranking of the seed lots regarding seedling emergence in the field. The efficiency of the procedure with use of the saturated salt solution for evaluation of soybean seed vigor was highlighted by Marcos-Filho et al. (2009) and Yagushi et al. (2014), among others.

The results of the primary root emergence test provided information similar to that coming from the germination test, identifying the higher vigor lots and showing lower sensitivity in identifying differences among the lots of lower physiological potential. In general, in its agreement with the results of the other vigor and seedling emergence tests, primary root emergence confirmed the efficiency emphasized by Powell (2022) for evaluation of the vigor of seeds of various species and justifies its inclusion in the International Rules for Seed Testing (ISTA, 2022).

In the traditional Vigor-S analyses, all the parameters evaluated were effective in identification of the seed lots of greater physiological potential (A1, A2, and A3) (Table 2). For the vigor index, mean seedling length, and root length, lots A4, A5, A7, A8, and A9 had lower performance, and lot A6 had intermediate performance. In evaluation of hypocotyl

Table 2. Vigor index (VI), seedling length (SL), hypocotyl length (HL), and primary root length (RL) obtained by Vigor-S analyses after traditional accelerated aging (TAA) and saturated salt accelerated aging (SSAA) in nine seed lot samples of soybean, cultivar NS 7007 IPRO. Mean of three evaluation times.

Vigor-S Analysis				
Lots	VI (index)	SL (cm)	HL (cm)	RL (cm)
A1	653 a	8.30 a	2.60 a	5.66 a
A2	722 a	9.06 a	2.83 a	6.22 a
A3	670 a	8.64 a	2.84 a	5.78 a
A4	331 c	3.58 c	1.71 b	1.85 c
A5	296 c	2.80 c	1.39 c	1.39 c
A6	384 b	4.42 b	1.90 b	2.47 b
A7	312 c	3.16 c	1.49 c	1.63 c
A8	313 c	3.18 c	1.45 c	1.72 c
A9	306 c	3.10 c	1.54 c	1.53 c

Continue...

Table 2. Continuation.

Vigor-S Analysis after TAA				
Lots	VI (index)	SL (cm)	HL (cm)	RL (cm)
A1	357 a	4.24 a	1.77 a	2.45 b
A2	364 a	4.78 a	1.99 a	2.80 a
A3	353 a	4.48 a	2.02 a	2.42 b
A4	183 b	0.74 b	0.52 b	0.18 c
A5	133 c	0.54 b	0.39 b	0.12 c
A6	170 b	0.80 b	0.44 b	0.33 c
A7	136 c	0.56 b	0.34 b	0.20 c
A8	133 c	0.58 b	0.37 b	0.19 c
A9	107 c	0.45 b	0.29 b	0.11 c
Vigor-S Analysis after SSAA				
Lots	VI (index)	SL (cm)	HL (cm)	RL (cm)
A1	596 a	7.34 a	2.47 a	4.86 a
A2	632 a	7.56 a	2.55 a	5.00 a
A3	628 a	7.68 a	2.55 a	5.13 a
A4	263 b	2.44 b	1.41 b	1.02 b
A5	255 b	2.16 b	1.23 c	0.91 b
A6	295 b	2.68 b	1.40 b	1.28 b
A7	265 b	2.16 b	1.16 c	0.97 b
A8	253 b	2.10 b	1.13 c	0.96 b
A9	248 b	2.16 b	1.17 c	0.96 b

(1) Mean comparison within each column (Scott-Knott test, $P \leq 0.05$).

length, lot A4 was similar to lot A6, whereas the other lots showed performance similar to that observed for the other parameters evaluated by Vigor-S.

Thus, in the analyses made with the Vigor-S system, similarity was observed in classification of the lots of better performance, among the parameters analyzed, in agreement with the results obtained in traditional vigor tests, in which the highest vigor lots were identified (Table 1). In a similar way, the consistency of the Vigor-S analyses in discriminating the vigor of the lots had been highlighted in seeds of maize (Castan et al., 2018), common bean (Medeiros et al., 2019), melon (Leite et al., 2020), and soybean (Rodrigues et al., 2020).

Regarding Vigor-S analyses after traditional accelerated aging, all the parameters evaluated identified lots A1, A2, and A3 as those of better performance, and lots A4 to A9 as those of lower performance. Vigor-S analyses after accelerated aging with saturated salt solution confirmed the greater vigor of lots A1, A2, and A3, and also did not establish sharp differences among the responses of lots A4 to A9.

Reductions in the vigor index and mean length of seedlings and of their parts were observed in the Vigor-S analyses after the traditional accelerated aging test compared to the analyses made after accelerated aging with the saturated salt solution. This is related to higher relative moisture in the traditional treatment compared to the use of the saturated salt solution, as already highlighted. According to Marcos-Filho (2016), one of the advantages of use of the saturated salt solution in the accelerated aging test is ensuring a more uniform moisture content among the samples evaluated, as well as control of microorganisms while the test is being carried out.

Carneiro and Guedes (2002) highlighted that interpretation of the accelerated aging test for evaluation of physiological potential has been directed mainly to calculation of the final germination percentage (normal seedlings), whose mean values can be related to the results of other vigor tests. According to these authors, the results of accelerated aging are generally the consequence of the degree of tolerance to the adverse conditions of temperature and relative humidity, mainly expressed by survival of the seeds and not necessarily by biochemical changes that determine the speed of germination and the seedling growth rate, that is, deterioration events that precede seed death. Consequently, they suggested studies directed to determination of the possibility of interpretation of the accelerated aging test through evaluation of the speed of germination or of mean seedling growth, complementing the traditional procedure, instead of direct determination of the percentage of normal seedlings.

The Vigor-S analyses after traditional accelerated aging showed similarity in identification of the lots of highest vigor for all the parameters analyzed, except for primary root length. These results consequently showed the consistency of the information obtained in Vigor-S analysis after the accelerated aging test with the saturated salt solution, separating the performance of the seed lots with higher and lower vigor in a way comparable to that carried out after conducting the tests recommended for evaluation of soybean seed vigor and validated by the ISTA. These observations regarding the reliability of the use of resources of computerized analysis of seedling images to complement the accelerated aging test with saturated salt solution corroborate the information highlighted by Marcos-Filho et al. (2009), Yagushi et al. (2014), and Leite et al. (2020). Based on these considerations, the use of Vigor-S for complementing accelerated aging can be considered a promising alternative for composing quality control programs, and it merits consideration in future observations.

The evaluation of seed vigor in laboratories of seed production companies has evolved to the extent that available tests have been refined, allowing consistent and reproducible results to be obtained, and also because new procedures have been introduced. Therefore, image analysis with the Vigor-S software arises as an important tool to complement the information provided by the accelerated aging test, leading to accurate evaluation, as well as reduction in the time necessary for complementation of the test. At the same time, it allows automatic evaluation of different parameters in the same determination, without the need for conducting additional tests, representing savings in time and labor, with less interference of the analyst in interpretation of the results. Furthermore, according to França-Silva et al. (2023), the possibility of storage and sharing of information in the form of digital images is another important convenience of computerized seedling image analysis in relation to filing numerical data, as occurs in traditional tests for vigor evaluation.

The results obtained here showed that seed lots of high physiological potential were evaluated. All the tests conducted produced comparable results, likewise in association with seedling emergence in the field, one of the main requirements for characterizing an efficient test for vigor evaluation. These results have provided useful information regarding determination of soybean seed vigor, indicating that the use of the Vigor-S system, alone or as an auxiliary component of the accelerated aging test, constitutes a promising option for composing quality control programs of soybean seeds, and possibly of other species.

CONCLUSIONS

Computerized analysis of seedling images with use of the Vigor-S software, complementing accelerated aging, is sensitive and efficient in determination of soybean seed vigor and in composition of quality control programs adopted by seed production companies.

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