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RESEARCH ARTICLE

COMPUTERIZED ANALYSIS IN THE PHYSIOLOGICAL QUALITY OF COFFEE SEEDS

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ABSTRACT

All technology developed by plant breeding programs is spread through seed and image analysis has proved to be a promising technique in assessing the viability of seeds per constitute an objective method, economical and practical. Thus, the objective with the survey was evaluate the physiological quality of coffee seeds submitted to drying and to estimate the seedling vigor through the Seed Analysis System (SAS ®) in order to correlate them with the quality seeds. Coffee seeds were dried until they reach levels of 40%, 20%, 15% and 12% of water by slow drying in the shade. After this process, the quality of the seeds was evaluated by germination test and first count. The SAS® equipment was used to estimate the strength and uniformity of coffee seedlings obtained during the course of the germination test. The use of images with the help of SAS® program analysis is a promising method for assessment of the viability and vigor of coffee seeds and seedlings.

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INTRODUCTION

The demand for coffee seedlings (*Coffeaarabica* L.) to ensure the plant population in the country is very large, so it is important to use high seed quality to obtain vigorous seedlings and thereafter the crop productivity. An undesirable characteristic of seeds for this species is that they have slow and uneven germination, making it difficult to obtain vigorous seedlings. Furthemore, this feature prevents the rapid assessment of the viability and vigour due to the excessive time required for obtaining the results (Rosa and McDonald Jr, 2011). The vigour tests are considered important in the verification of subtle variations in the seeds quality, identifying different stages of deterioration of a seed lot (Baalbaki *et al*., 2009). The germination test, despite having high level of reliability as one of the parameters used to the normalization of seeds production and marketing, has limitations on the use of the results to estimate the seedling vigor under less favorable environment conditions (Marcos Filho, 2010). The mechanization and automation of analytical procedures have enabled advances in seed quality control of various species, as an example of the use of automated computer imaging system for seedling evaluation, aiming to determine the seed vigour. Image analysis has proved to be a promising technique, especially for technological development level, which is reflected in advances in the capture capability, treatment and images interpretation. For Carvalho (2010), in the seeds area, the image analysis is extremely useful as the development of simple methods, rapid and non-destructive for seed quality assessment, to enable an estimate of storage potential or development field, is of great importance to the establishment of dynamic and efficient quality control programs. Different authors used the computer imaging analysis technique for the purpose of evaluate the germination, vigor and characteristics of color of seeds in different species (Marchi *et al*., 2011; Alvarenga *et al*., 2012; Andrade *et al*., 2016). This technique aims at capture and image processing based on software that take out information of various seeds and seedlings. Among the equipment and computer programs used to analyze images, the Image Analysis System - SAS ® is an image analysis equipment of seeds and seedlings with potential use of seeds quality control, as a vigor test (Pinto *et al*., 2015). Thus, the objective of this study was to evaluate the physiological quality of coffee seeds submitted to drying and to estimate the seedling vigor through Seed Analysis System - SAS ®.

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MATERIALS AND METHODS

The research was conducted at Seed Central Laboratory of the Federal University of Lavras (UFLA), in Lavras-MG. Were used *Coffea arabica* L. seeds, Mundo Novo, obtained in the

UFLA production fields. The coffee fruits were harvested selectively in the cherry stage being pulped and mechanically demucilaged before drying. At this moment, the moisture content in seeds was 50% (control not submitted to drying). The seeds were dried until moisture contents reached 40%, 20%, 15% and 12% (wb) by slow drying in the shadow. The seed moisture content was determined by oven-drying method at 105 ° C for 24 hours, using two subsample for each treatment (Brasil, 2009). Germination test – Was accomplished with four replicates of 50 seeds each treatment. The substrate used was paper towels in roll form, moistened with a quantity of water equivalent to 2.5 times the dry weight of the substrate and maintained in germinator at 30 ° C. The counts were made at fifteen, thirty and forty-five days after sowing (Brasil, 2009), and the results expressed as a percentage of normal seedlings. First count - Effected the fifteenth day of the beginning of the germination test, computing the seeds that had taproot and at least two lateral roots, the results were expressed as a percentage. Image analysis using SAS - To carry out the capture of images of coffee seedlings, germination tests were performed with eight replicates of 25 seeds each treatment. The seeds were distributed in two rows (one at the top, and one in the middle of the paper). The rolls were placed in germinator at 30 ° C for 45 days, with images captured at 30 and 45 days. The coffee seedlings were removed from the towel and placed in the paper tray of the machine so that the seedlings stay separated from each other. After the tray is inserted into the SAS equipment to image collection and was realized the image capture by a professional camera, high resolution. Subsequently, the background color calibration using the CIELab color model was done with a brightness of 0 to 100, the dimension "a" of -120 to 120, and the dimension "b" of -120 to -30. The type of recognition parameter was coffee seedlings, unselected fill background and the minimum size of object disposal of 0.3 cm^2. The second step was to perform image analysis of the seedlings. After the analysis was obtained the report that has all the vigor values, uniformity and growth of coffee seedlings.

We used a completely randomized design with four replications according to analysis of the four levels of water after drying (40%, 20%, 15% and 12%) plus the control (50% without drying). Data analyzes were performed using the statistical program SISVAR® (Ferreira, 2011).

RESULTS AND DISCUSSION

The uniformity of moisture content between treatments is important to obtain consistent results in the evaluation of the physiological potential of the seeds (TEKRONY, 2003). For commercial production of coffee seeds is recommended drying around 10% of humidity and storage in airtight containers under temperature between 10 and 15 °C (HONG and ELLIS, 1992). There were no significant differences in the seeds that were submitted to drying in different degrees of humidity on the results of the first count (Table 1). The first count of germination assess the normal seedling percentages that are obtained during the first evaluation of the germination test in the sample under analysis, being effective to determine seed vigor (NAKAGAWA, 1999). By germination analysis was observed superiority of the physiological quality for coffee seeds with moisture contents of 15 and 12%. According to Araújo *et al*. (2008) coffee seeds submitted to drying process in the shadow and stored with humidity from 14 to 18% maintained their germination above 80% for a satisfactory period (nine months). The moisture content most appropriate to conservation of coffee seeds has not been defined in reason of the divergences between advanced search results. Until the 45th day the germination percentage was unchanged, noting that at this stage, is possible to note that the seedlings have their open cotyledons. The quality assessment by image analysis is a technique studied in the seeds of several species, and have shown promise for automation of the assessment of viability and vigor tests in seeds, with a potential also for reducing the time required to report the results. Table 2 shows the image analysis results obtained from the use of Seed Analysis System - SAS ®.

No differences were observed between the treatments studied in relation to the rates uniformity and the vigor of the coffee seedlings at 30 and 45 days after sowing, thus, these rates were not efficient in the evaluation of vigor. The uniformity of seedling growth is directly related to seed vigor, wherein, high vigor seeds have a uniform emergency (Engli and Rucker, 2012). For dried seeds to 12, 15 and 50% better performance was observed in the seedlings growth at 30 days (Figure 1). The moisture content most appropriate for conservation of coffee seed has not been defined due to differences between the results obtained from surveys, which corroborates with the results presented in this study.

Table 1. Average results obtained in the evaluation of the physiological quality of coffee seeds with different moisture contents by First Count Germination test (PC), Germination (G), germination on the 45th day after sowing (G45)

Treatment	PC	G	G45
40%	93 a	76 b	76 b
20%	93 a	78 b	78 b
15%	93 a	91 a	91 a
12%	99 a	91 a	91 a
50%	100 a	90 a	90 a
CV(%)	5,04	9,59	9,59

Means followed by the same letter in the columns donot differ by Scott-Knott test at 5% probability

Table 2. Image Analysis of coffee seedlings by SAS®: Growth (CRES), Uniformity (UNIF) and Vigor at 30 and 45-day evaluation

Treatment	CRES(30)	UNIF (30)	VIGOR (30)	CRES(45)	UNIF(45)	VIGOR(45)
12%	31[a]	74a	44a	53a	72a	59[a]
15%	33[a]	70a	44a	56a	62a	58[a]
20%	23b	61a	34a	34c	70a	45[a]
40%	26b	56a	35a	39c	68a	48[a]
50%	32[a]	54a	39a	47b	65a	52[a]
CV(%)	15,22	26,77	15,7	8,43	30,35	13,99

Means followed by the same letter in the columns do not differ by the Scott-Knott test at 5% probability

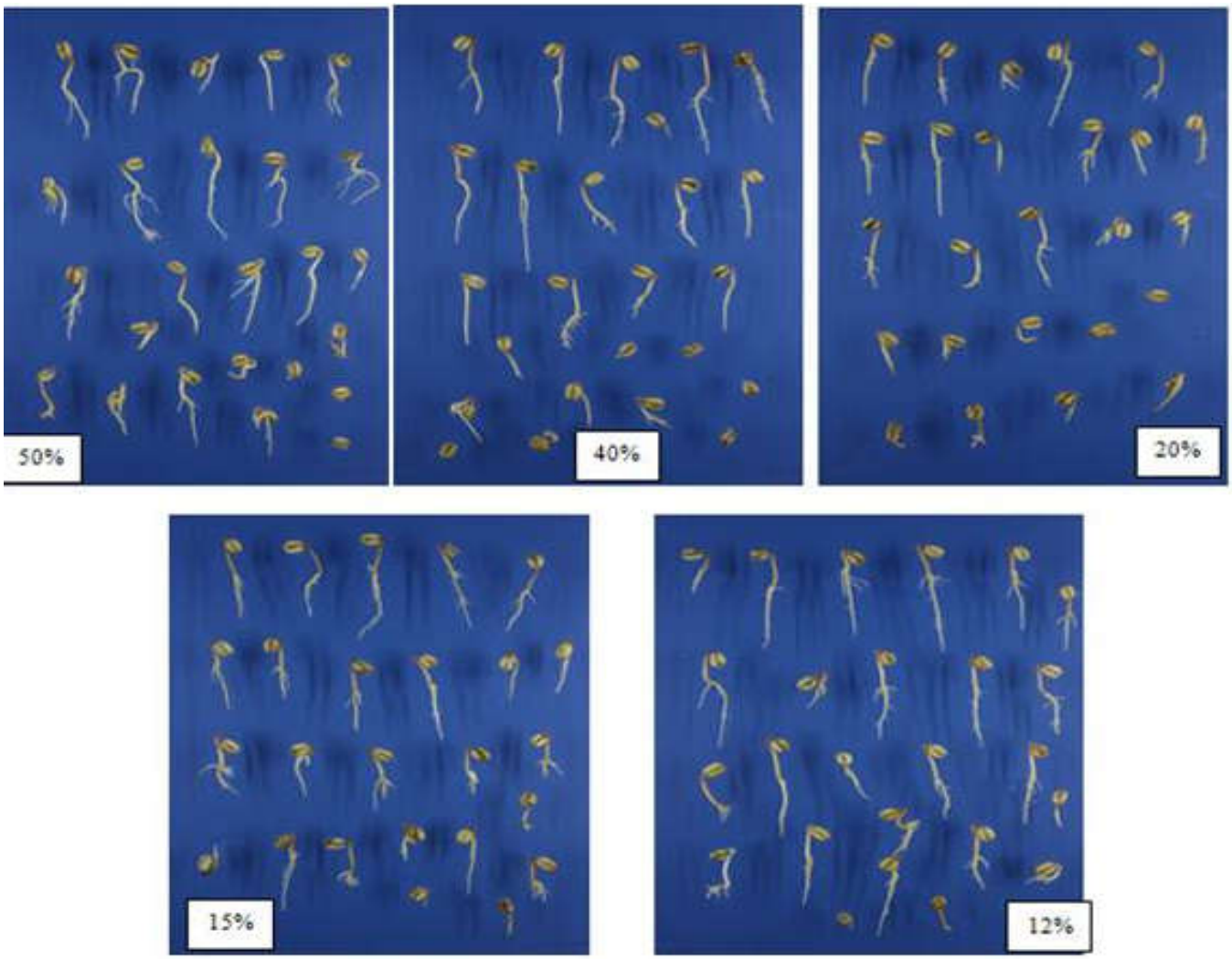

Figure 1. Images of coffee seedlings obtained by SAS® in the evaluation of the physiological potential of dried seeds at different moisture contents captured 30 days after sowing

Note that the average growth of seedlings at 30 and 45 after sowing was an effective parameter for evaluating coffee seeds, as the results show consistency with those obtained in the germination test that show 12 and 15% humidity as those who had higher germination values, and clear the relationship between moisture content and the vigor in seeds of this species. According to Pinto *et al*. (2015) the initial length (growth) of corn plants is directly related to seed vigor, a fact also reported by Mondo *et al*. (2013) that evaluated the effect of the seed vigor of maize in the initial growth of seedlings. Seedlings originating of the treatments studied followed the same trend of uniformity, which also reflected in seedling vigor. The analysis obtained by SAS in coffee seedlings were consistent with the visual analysis at 30 days. Whereas this is the method prescribed for the germination test in Seed Analysis Rules (Brasil, 2009), should recommend it as a reference for comparison with the tests performed by image analysis. Thus, it can guarantee that the use of SAS is possible to analyze the effect on coffee seeds, being a viable, innovative and promising alternative for quality assessment.

Conclusion

The use of images through SAS® program analysis is a promising method for assessing the viability and seed vigor and coffee seedlings.

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