Use of digitized images to evaluate the quality of coffee seeds

https://doi.org/10.56238/sevened2023.001-023

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ABSTRACT
The analysis of digital images consists of the generation of dimensional data, such as width, length and area, or attributes, such as color and texture of a captured image, and their measurement by means of counting or frequency methods. The use of image analysis to evaluate the physiological quality of seeds has been considered an objective, economical and practical method. Thus, this work was carried out with the objective of comparing the results of the evaluation of the physiological quality of coffee seeds obtained in the germination tests with those obtained from the analysis of digitized images. Thirty-two lots of coffee seeds were used, which were submitted to conventional analysis and image analysis using the computer program WINFOLIA.® Although additional research is needed to confirm the results, it has been observed that the image analysis method can accurately provide the germination and vigor of coffee seeds in a more practical, economical and anticipated way than the conventional test.

Keywords: *Coffea arabica*, Physiological, Technology.

1 INTRODUCTION

Coffee growing in Brazil is one of the most significant agricultural activities, both because of the volume of financial resources involved and because of the use of a significant amount of labor, with a decisive contribution to the development of municipalities in the producing regions (Rena & Maestri, 1986).

Coffee plantations are implanted from seedlings and one of the critical points for their production is to obtain quality seeds, especially vigor. Many steps and care must be taken during seed production, which must be completed with the analysis to evaluate the final quality of the seeds in order to ensure high viability and vigor for the formation of seedlings with the necessary quality for the implementation of vigorous and productive crops. However, the evaluation of the quality of coffee

seeds is a laborious and time-consuming step, since it depends on the removal of the parchment to perform the germination test, which lasts at least thirty days, or the removal of the embryos, an activity that requires a lot of skill and time from the laboratory, when faster results are desired using the tetrazolium test.

The evaluation of seed quality by means of image analysis is a technique studied for several crops and has shown promise for automating the evaluation of viability and vigor tests in seeds, with the potential to reduce the time needed to issue the results (Hoffmaster, 2003).

According to Teixeira, Cícero & Dourado Neto (2003), there has been a favorable evolution for the improvement of computerized techniques, which are more sensitive for capture and more precise for the processing and extraction of useful information for the seed industry, defining an amplification of sensitivity by digital means.

The WINFOLIA® software, owned by Regent (2005) was developed to measure the leaf area of seedlings, from the capture of images in scanners and subsequent analysis of them, with the aid of a computer program.

Therefore, the objective of this research was to evaluate methodologies for the determination of the physiological quality of coffee seeds, using the image analysis technique using the WINFOLIA software.

2 MATERIAL AND METHODS

Thirty-two lots of coffee seeds (*Coffea arabica* L.), with different levels of physiological quality, obtained from UFLA plantations were used. The seeds were submitted to the germination test, where the percentage of root protrusion, normal seedlings at fifteen and thirty days old (Brazil, 2009), strong and weak normal seedlings, and shoot and root dry mass were evaluated.

At the end of the germination test, images of the hypocotyls of the seedlings were captured, which were removed from the seedlings with the aid of a scalpel. The images were processed and digitized using the WINFOLIA® software, specific for the measurement of leaf area, resulting in measurements of the mean area per seedling, total area of the hypocotyls, mean perimeter and total perimeter of the hypocotyls. These results were then correlated with the results obtained in the germination test.

The ASSISTAT software was used for correlation analysis.

3 RESULTS AND DISCUSSION

From the analysis of the results, it was observed that there was a significant correlation between the values of the total area of the hypocotyls of the seedlings, obtained from the correlated image analysis, and all the other results of the evaluation of the physiological quality of the coffee seeds,

obtained through the germination test. The high correlation obtained between this variable and the percentage of normal seedlings at 30 days of age, from 80% to the 1% level of significance, is noteworthy. The value of the mean hypocotyl area per seedling showed a significant correlation only with the percentage of normal seedlings at 30 days, of weak normals, although with lower correlation coefficients.

The total perimeter values of hypocotyls were also correlated with the results of all conventional tests to evaluate the physiological quality of the coffee seeds used, highlighting the high correlation coefficient of this variable with the percentage of normal seedlings at 30 days and root protrusion. The mean hypocotyl perimeter values of the seedlings did not correlate with any of the other results of quality evaluation by means of the germination test. The result of the analysis of digitized images that best correlated with the final result of the germination test, i.e., the percentage of normal seedlings at thirty days, was the total area of hypocotyls of the seedlings evaluated in this study (Table 1)

Table 1. Correlation coefficients between the results of conventional and image analysis tests. SDA-total area of hypocotyls. MDA-Mean Hypocotyl Area. SDP-total perimeter of hypocotyls. MDP-mid-hypocotyl circumference. MSA-seedling shoot dry mass. MSR-dry mass of seedling roots. Seedling-seedling dry mass. N30-percentage of normal seedlings. N Weak-percentage of weak normal seedlings. N Strong - percentage of strong normal seedlings. Dead-percentage of dead seedlings. FLSCO-percentage of seedlings with open cotyledonary leaves at 45 days. Significance levels: ns – not significant; * - significant at the level of 5%; ** - significant at the level of 1%.

	SDA	MDA	SDP	MDP	MSA	MSR	Seedling
SDA		0.6667**	0.8912**	0.3328**	0.1855*	0.1599*	0.1889*
MDA	0.6667**		0.5792**	0.6725**	0.0480ns	0.1424ns	0.1472ns
SDP	0.8912**	0.5792**		0.5966**	0.0682ns	0.0934ns	0.1031ns
MDP	0.3328**	0.6725**	0.5966**		-0.1836*	0.0141ns	-0.0193ns
MSA	0.1855*	0.0480ns	0.0682ns	-0.1836*		0.0602ns	0.2384**
MSR	0.1599*	0.1424ns	0.0934ns	0.0141ns	0.0602ns		0.9837**
Seedling	0.1889*	0.1472ns	0.1031ns	-0.0193ns	0.2384**	0.9837**	
Prot Rad	0.7706**	0.3362**	0.6643**	0.0115ns	0.1388ns	0.1166ns	0.1384ns
N30	0.8065**	0.2747**	0.6846**	-0.0295ns	0.1503*	0.1137ns	0.1377ns
N Weak	0.3120**	0.1784*	0.1732*	-0.1167ns	0.0889ns	0.2225**	0.2325**
N strong	0.3037**	0.0326ns	0.3477**	0.0922ns	0.0264ns	-0.1324ns	-0.1240ns
Dead	-0.7856**	-0.3270**	-0.6743**	0.0039ns	-0.1341ns	-0.1224ns	-0.1432ns
Abnormal	-0.2103**	0.0645ns	-0.1608*	0.0698ns	-0.0744ns	-0.0284ns	-0.0410ns
FLSCO	0.5975**	0.4574**	0.4325**	0.1088ns	0.2448**	0.1647*	0.2043**
	Prot Rad	N30	N Weak	N strong	Dead	Abnormal	FLSCO
SDA	0.7706**	0.8065**	0.3120**	0.3037**	-0.7856**	-0.2103**	0.5975**
MDA	0.3362**	0.2747**	0.1784*	0.0326ns	-0.3270**	0.0645ns	0.4574**
SDP	0.6643**	0.6846**	0.1732*	0.3477**	-0.6743**	-0.1608*	0.4325**
MDP	0.0115ns	-0.0295ns	-0.1167ns	0.0922ns	0.0039ns	0.0698ns	0.1088ns
MSA	0.1388ns	0.1503*	0.0889ns	0.0264ns	-0.1341ns	-0.0744ns	0.2448**
MSR	0.1166ns	0.1137ns	0.2225**	-0.1324ns	-0.1224ns	-0.0284ns	0.1647*

Plantula	0.1384ns	0.1377ns	0.2325**	-0.1240ns	-0.1432ns	-0.0410ns	0.2043**
Prot Rad		0.8846**	0.4332**	0.2437**	-0.9534**	-0.0337ns	0.4650**
N30	0.8846**		0.3604**	0.4024**	-0.9098**	-0.3810**	0.5141**
N Weak	0.4332**	0.3604**		-0.7089**	-0.4265**	0.0675ns	0.2059**
N strong	0.2437**	0.4024**	-0.7089**		-0.2693**	-0.3544**	0.1866*
Dead	-0.9534**	-0.9098**	-0.4265**	-0.2693**		-0.0097ns	-0.4761**
Abnormal	-0.0337ns	-0.3810**	0.0675ns	-0.3544**	-0.0097ns		-0.1836*
FLSCO	0.4650**	0.5141**	0.2059**	0.1866*	-0.4761**	-0.1836*	

4 CONCLUSION

The use of image analysis with the aid of the WINFOLIA® program is a promising method for the evaluation of the viability and vigor of coffee seed lots, especially using the total area of seedling hypocotyls.

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