IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Review On Non Destructive Seed Quality Testing Methods And Technique

[1]Pooja S. Deshmukh, [2]S. P. Kharde, [3]S. S. Gadekar
[1] Research scholer, [2,3]Assistant Professor
[1,2,3]Electronics & Telecommunication Engineering department,
[1,2,3]Shreeyash College of Engineering & Technology, Chh. Sambhajinagar,India.

Abstract: Seed testing is crucial for modern agriculture, as it ensures the quality, purity, and viability of seeds before planting. By evaluating parameters like purity, germination potential, moisture content, and seed health, seed testing provides vital information for farmers and seed producers to make informed decisions about planting and crop performance. It also helps prevent the spread of diseases and pathogens, contributing to sustainable farming practices and increased productivity. Mainly there are two methods of seed testing, destructive testing and non-destructive testing. As it clear that sample is destroyed in destructive testing method and based on its result batch of that seeds quality estimated. In non-destructive testing method seed samples are tested using computer vision and electronics sensors. In this this paper various seed testing methods like computer vision, image processing, spectral analysis of non-destructive testing are explore with key benefit and their limitations.

Index Terms - NDT of seed, Image processing, Seed quality testing, Multispectral testing, Computer vision.

I. Introduction

The seed testing helps to identify quality standard of sample seed by which farmer can estimate efficient and productive seed before plantation. It helps saving time and financial losses. When seed is tested, the sample on which the test is made has to be representative of the whole. Therefore, every effort must be made to ensure that the sample accurately reflects the composition of the whole seed lot [11]. The testing of seeds involves seed purity analysis, seed weight, moisture content, and germination properties. The seed purity testing can be a genetic purity or physical purity. Viability testing is done to determine percentage of live seed that has potential to germinate and grow and turn to healthy seedling plant. Most of these tests are carried out in laboratories. Hence only sample can be tested from a lot. In non-destructive testing method morphological data of extracted from seed by image processing technique. Advancement in this is multispectral imaging in which different wavelength image data of sample is captured and analyzed. The different methods and technique of seed is discus below in literature review.

II. Literature Review

Shuheng Zhang[1] has published article “Non-Destructive Testing of Alfalfa Seed Vigor Based on Multispectral Imaging Technology” In this experiment 19 different wavelengths (365, 405, 430, 450, 470, 490, 515, 540, 570, 590, 630, 645, 660, 690, 780, 850, 880, 940, 970 nm) were used to detect the surface characteristic of object[1]. The multispectral imaging instrument VideometerLab4 was used to take seed sample images. The spectral information and seed morphology information collected by MSI were used for multivariate analysis: Principal component analysis (PCA), as an exploratory technique of multivariate data analysis, identifies morphological characteristics of extracted seeds and hidden patterns in spectral data, and is used to obtain an overview of systematic changes in the data. The result of analysis and conclusion of author is morphological data and spectral information of seeds extracted by MSI, combined with the LDA model and nCDA model, can accurately measure the seed vigor, viability and germination percentage of alfalfa, so as to achieve the established goal of predicting the seed germination ability quickly and nondestructively. The above method is suitable for the determination of seed vigor level difference caused by different level of maturity during seed development, and also for the determination of differences in seed vigor level caused by natural aging during different storage years after physiological maturity, which has good applicability and representativeness. The chlorophyll fluorescence imaging technique also provides a new idea for early identification of seeds with high or low vigor. The results of their experiment provide an important reference and basis for further exploring the application of multispectral imaging technology in seed quality testing.

Ye Rin Chu[2] published article Non-Destructive Seed Viability Assessment via Multispectral Imaging and Stacking Ensemble Learning. This study demonstrates that a stacking model using spectral data can effectively and non-destructively distinguish between viable and non-viable seeds, with an accuracy of approximately 90%. Identifying critical wavelengths (570, 645, and 940 nm) provides a reliable basis for assessing seed viability. The results of this study align with previous research, confirming the potential of machine learning-based approaches in this field. while this study presents a promising approach for non-destructive seed viability assessment, further validation of the model across different species and larger datasets will be critical to ensure its broader applicability. Future research will incorporate auto fluorescence spectral images collected with VideometerLab 4 to improve classification accuracy further and expand the model’s capabilities.

Hongyi Ge[3] has published Research on “Non-Destructive Quality Detection of Sunflower Seeds Based on Terahertz Imaging Technology”[3]. In this study, author proposed a non-destructive inspection model MobileViT-E for sunflower seed quality. It was based on the MobileViT model and used the Transformer architecture to extract the multi-scale features of sunflower seed images. It acquired and analysed the subtle features of the images through the self-attention mechanism and global feature extraction. The EMA mechanism was introduced in the MobileViT block to further improve its performance. This optimised the model’s attention on the basic image features and reduced the interference from irrelevant information while retaining the necessary information from each channel to reduce the computational cost. Additionally, the ELU activation function was used in the MV2 structure to avoid the vanishing gradient problem, speed up network training, and improve the model’s generalisation ability.

Saidul Tua Manik[4] has published research paper “The development of non destructive testing methods for water content and viability of soybean seed using standing wave”. Non destructive methods using standing waves can be used to differentiate seed quality based on the resulting absorption coefficient value. The higher the number and the higher the water content of the seed, the resulting coefficient of absorption increases. The number of selected seeds that can be used in the measurement of the absorption coefficient is 120 grains with the frequency range 4000Hz - 4750Hz.On 4750 Hz water content levels can be detected well, while the 4250-4000Hz frequency of coefficient value is able to distinguish between viable and nonviable seeds.

Weibin Jiang [5] has published paper “Machine learning-based non-destructive terahertz detection of seed quality in peanut”. This study demonstrates the efficacy of combining terahertz imaging technology with convolutional neural networks for rapid and nondestructive detection of peanut quality. The proposed methods achieved a high accuracy of 98.7% in distinguishing five different seed qualities: standard, mildewed, defective, dried and germinated. The terahertz wave images revealed distinct characteristics for each quality type, enabling precise identification without damaging the seed structure. The developed system significantly reduced detection time to an average of 2.2 s per seed, approximately 375 times faster than traditional methods. This substantial improvement in speed, coupled with the elimination of sample preparation steps, makes this study approach highly suitable for real-time, continuous quality assessment in industrial settings. This paper's findings represent a significant advancement in seed quality detection technology, offering potential benefits for food safety and quality control in the peanut industry. The high accuracy, speed and non-destructive nature of the proposed method make it valuable for large-scale quality assessment throughout the peanut supply chain. Future research could explore the application of the proposed method to other crop types and its integration into existing production lines to enhance quality control processes in the food industry.

Abadi F R[6] has published “A Study of Characterization Procedure for Non-destructive Testing of Soybean Seed based on Spectroscopy”. The development of measurement procedures on portable spectrometers on Visible/NIR spectroscopy, can be done by observing several treatments with probing distance, probing angle and sample preparation mode. In overall, all of the treatments were shown significantly different ($p<0.05$; Tcal.>Ttab.) except for 0 cm probing distance and 450 of probing angle. The best distance at an observation distance of 1-1.5 cm is at 0.5 cm. The best observation angle is 900 with the sample preparation mode in the form of a single seed. This can be done as an effort to minimize measurement errors and optimize the results of spectra observations. Therefore, based on the observation result, it is recommended for the portable spectrometer application on soybean, that observations appropriately to be done on a single seed by not attaching the observation probe directly to the material and to be carried out perpendicular to the material.

Adriano Griffo[8] has published paper entitled Non-invasive methods to assess seed quality based on ultra-weak photon emission and delayed luminescence. The measurement of ultra-weak photon emission (UPE) and delayed fluorescence (DL), defined as biological phenomena potentially related to the physiological status of living systems, may represent a suitable approach to estimate seed quality. To test this hypothesis, seeds of five agriculturally relevant legume species (Phaseolus vulgaris L., Lathyrus sativus L., Cicer arietinum L., Pisum sativum L., and Vicia faba L.), stored at different conditions (room temperature or -18 °C) for several years, were analysed using a LIANA© prototype to collect data regarding DL and UPE occurring after UV excitation. The obtained data were integrated with germination parameters which underline species-specific behavior’s in response to storage conditions. The prediction models show variable efficiency in classifying seeds based on germination which underline species-dependent links between photon emission and seed quality. Therefore, these measurements represent novel, non-invasive, and rapid approaches to evaluate seed quality.

Ms. Mrinal Sawarkar [10] has published paper “Digital Image Processing Applied to Seed Purity Test”[10]. This paper describes the survey of different Digital image processing techniques for seed purity evaluation. It describes how the imaging technology is applied in monitoring seed imbibition, purity behavior and analysis of seed size, shape parameters. Recently, the greatest efforts have focused on producing nondestructive methods with capability of computer hardware of image processing and its integration with controlled environmental condition systems.

III. DISCUSSION

The non-destructive testing has several benefits as we have discus in literature review section. The technologies used are multispectral imaging, terahertz imaging, Standing waves, NIR and visible imaging. In normal imagining only morphological shape and outer appearance of seed data captured. Next part is image processing and analyzing is almost common in research article presented here. For processing data different methods and algorithm were used. The standing wave used for detection of water contents and seed quality is ahead of normal imaging technologies as it explore the inside of seed. Because seed quality decided by purity, water contents that is moisture contents and specific weight of seed. Purity in term of shape and color can be identified using imaging technique and multispectral imaging has more insight into that but it can’t sense the moisture content or specific weight of seed. Terahertz waves are in between microwave and infrared .Terahertz spectroscopy can provide physical as well as chemical composition of seed.

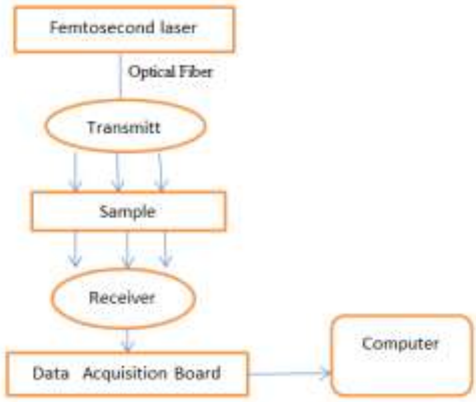

Figure 1.1 Terahertz Spectroscopy block diagram

IV. CONCLUSION

The non destructive testing techniques for seed quality testing discus in this paper explore that all the parameters are necessary to decide the quality of seed. Imaging vision based system with image processing can detect outer physical parameters like shape, color. Standing wave absorption can detect moisture content in seed whereas by using terahertz spectroscopy we identify physical as well as chemical composition of sample. Among all the methods Terahertz spectroscopy is found to be more accurate to justify the seed quality.

REFERENCES

[1] Zhang, S.; Zeng, H.; Ji, W.; Yi, K.; Yang, S.; Mao, P.;Wang, Z.; Yu, H.; Li, M. Non-Destructive Testing of Alfalfa Seed Vigor Based on Multispectral Imaging Technology. Sensors 2022, 22, 2760. https:// doi.org/10.3390/s22072760

[2] Chu, Y.R.; Jo, M.S.; Kim, G.E.; Park, C.H.; Lee, D.J.; Che, S.H.; Na, C.S. Non-Destructive Seed Viability Assessment via Multispectral Imaging and Stacking Ensemble Learning. Agriculture 2024, 14, 1679. https://doi.org/10.3390/ agriculture14101679

[3] Ge, H.; Guo, C.; Jiang, Y.; Zhang, Y.; Zhou,W.;Wang, H. Research on Non-Destructive Quality Detection of Sunflower Seeds Based on Terahertz Imaging Technology. Foods 2024, 13, 2830. https://doi.org/ 10.3390/foods13172830

[4] Saidul Tua Manik, Muhammad Rahmad Suhartanto, "The development of non destructive testing methods for water content and viability of soybean seed using standing wave", International Journal of Agronomy and Agricultural Research (IJAAR), ISSN: 2223-7054 (Print) 2225-3610 (Online) http://www.innspub.net Vol. 11, No. 3, p. 110-115, 2017

[5] Weibin Jiang a,c, Jun Wang, "Machine learning-based non-destructive terahertz detection of seed quality in peanut", https://doi.org/10.1016/j.fochx.2024.101675 Received 16 December 2023; Received in revised form 16 July 2024

[6] Abadi F R1, Masithoh R E, "A Study of Characterization Procedure for Non-destructive Testing of Soybean Seed based on Spectroscopy", The 4th International Conference on Sustainability Agriculture and Biosystem, IOP Conf. Series: Earth and Environmental Science 1059 (2022) 012015 IOP Publishing doi:10.1088/1755-1315/1059/1/012015

[7] Mingzhuo Li, Aditi Dey Poonam, "Non-destructive seed genotyping via microneedle-based DNA extraction", Plant Biotechnology Journal (2025) 23, pp. 2317–2329, doi: 10.1111/pbi.70055

[8]Adriano Griffo, Stefanie Sehmisch, "Non-invasive methods to assess seed quality based on ultra-weak photon emission and delayed luminescence", www. nature. Com /scientificreports, (2024) 14:26838, https:// doi.org/10.1038/s41598-024-74207-9

[9] Ren Zhang, Dinghai Xia, "Design of a Maize Seed Non-destructive Inspection and Precision Selection Device", https://ssrn.com/abstract=5340120

[10] Ms. Mrinal Sawarkar, Dr. S.V.Rode, "Digital Image Processing Applied to Seed Purity Test", International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering ISO 3297:2007 Certified, ISSN (Online) 2321 – 2004 ISSN (Print) 2321 – 5526 Vol. 5, Issue 5, May 2017

[11] https://www.fao.org/4/ad232e/AD232E09.htm

[12] Zhang, T.; Wei, W.; Zhao, B.; Wang, R.; Li, M.; Yang, L.; Wang, J.; Sun, Q. A reliable methodology for determining seed viability by using hyperspectral data from two sides of wheat seeds. Sensors 2018, 18, 813.

[13] Baek, I.; Kusumaningrum, D.; Kandpal, L.M.; Lohumi, S.; Mo, C.; Kim, M.S.; Cho, B.K. Rapid measurement of soybean seed viability using kernel-based multispectral image analysis. Sensors 2019, 19, 271.

[14] Leist, N.; Krämer, S.; Jonitz, A. ISTA Working Sheets on Tetrazolium Testing Volumes I and II; International Seed Testing Association: Wallisellen, Switzerland, 2003.

[15] ElMasry, G.; Mandour, N.; Al-Rejaie, S.; Belin, E.; Rousseau, D. Recent applications of multispectral imaging in seed phenotyping and quality monitoring—An overview. Sensors 2019, 19, 1090.

[16] ElMasry, G.; Mandour, N.; Ejeez, Y.; Demilly, D.; Al-Rejaie, S.; Verdier, J.; Rousseau, D. Multichannel imaging for monitoring chemical composition and germination capacity of cowpea (Vigna unguiculata) seeds during development and maturation. Crop J. 2022, 10, 1399–1411.

[17] Kafle B P 2020 Infrared (IR) spectroscopy In Chemical Analysis and Material Characterization by Spectrophotometry https://doi.org/10.1016/b978-0-12-814866-2.00007-5.

[18] Zhou L, Zhang C, Qiu Z and He Y 2020 Information fusion of emerging non-destructive analytical techniques for food quality authentication: A survey. Trends in An. Chemistry, 127115901.

[19] Rodriguez-Saona L E, Giusti M M and Shotts M 2016 Advances in infrared spectroscopy for food authenticity testing Advances in Food Authenticity Testing Elsevier Ltd https://doi.org/10.1016/B978-0-08-100220-9.00004-7.

[20] Amanah H Z, Joshi R, Masithoh R E, Choung M G, Kim K H, Kim G and Cho B K 2020 Nondestructive measurement of anthocyanin in intact soybean seed using Fourier Transform Near-Infrared (FT-NIR) and Fourier Transform Infrared (FT-IR) spectroscopy Infrared Physics and Technology 111 103477 https://doi.org/10.1016/j.infrared.2020.103477.