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Assessing Seed Vigor Characters of Selected Rice (*Oryza sativa* L.) Genotypes Using Accelerated Ageing Method

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Authors' contributions

This work was carried out in collaboration among all authors. Author SAH designed the study, performed the experiment, statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors WMT, HH and MWG managed the analyses of the study.

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ABSTRACT

Rice (*Oryza sativa* L.) is an annual grass with the third-highest world production after sugarcane and maize. However, due to losses in vigor caused by poor seed storage, global consumption has surpassed production. Preservation of germ plasma both in-situ and ex-situ is the key to the conservation of rich biodiversity. Seed vigor is a key element of seed quality and high vigor seeds give uniform plants stand and higher yields per area. Accelerated ageing tests enable testing the vigor of stored seeds by subjecting the seeds to a particular temperature and relative humidity over time and then performing standard germination tests. Viability of most seeds normally reduces with the storage period, storage temperature and relative humidity. There is limited information on the duration of storage for rice seeds. Accelerated ageing is considered an excellent option as a vigor test when compared to seedling emergence and index of emergence speed because of the shortest time of acquisition and efficient results. Accelerated ageing tests at 0, 24, 48 and 72 hours (45ºC and 98% RH) were carried out JKUAT post-harvest laboratory using eight rice varieties' in four replications of 100 seeds each. Data were analyzed using GENSTAT statistical package.

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ANOVA and T-tests at 5% significant level. Results showed that there was significant variation in both coleorhiza and coleoptile formation among rice varieties ($p<0.001$), treatments ($p<0.001$) and interaction between rice varieties and treatment ($p<0.001$). The difference between all treatments was significant with 72 hours' treatment having the highest number of days to coleorhiza and coleoptile formation. The present study has shown that prolonged duration of higher temperatures results in a reduction of seed viability. The earliest coleorhiza formation was observed on day 2 and the latest on day 6. Results from this study will guide farmers and seed processors on considerations regarding storage period and storage temperature to ensure high-quality seeds.

Keywords: Rice; seed quality; accelerated ageing; seed vigor.

1. INTRODUCTION

Rice (*Oryza sativa* L.) is the greatest and widely grown cereal crop after wheat in the world food grain production and is the key source of income for more than 150 million rural households [1].

Rice is fast improving a major food and cash crop in Kenya, following maize and wheat in terms of intake. In Kenya rice consumption rose by 12% in 2003 while for wheat it was 4% and maize 1%. Seed vigor affects productivity. Seeds scores good quality if it's devoid of diseases and the germinability and vigor is high. This causes viable gain from heightened farming systems and inputs.

Seed quality is among crucial features that governs the success or anticlimax of a crop. Seed vigor is a key element of seed quality. Vigorous seeds yield more even, robust plants stand eventually raising unit yields. Seed vigor influences field stand establishment and experiments reflects field performance [2]. Various researches suggest that germination test rarely totally point out loss in probable performance. The present study aims to assessing seed vigor characters of selected rice (*Oryza sativa* L.) Genotypes using the accelerated ageing method.

2. MATERIALS AND METHODS

The present investigation was carried out in the post-harvest laboratory at Jomo Kenyatta University of Agriculture and Technology, Juja during the year 2015. The three seeds lots of each cultivar were created by subjected to an accelerated ageing test for 0, 24, 48 and 72 days.

Eight seed lots were subjected to heat stress according to procedure described in Taylor et al. [3]. Seeds of varieties including Basmati 217, Basmati 370, Japan 54, Japan 64 were obtained from Kenya agricultural and livestock Research Institute while other genotypes including mzungu, Uzungu and Supasaro were obtained from local farmers.

Seed lots from each genotype were placed in petri dishes inside an elevated screen. The screen was placed into an acrylic box containing 40 ml of water. The box is covered with a tight-fitting lid and placed into the AA chamber at 45°C and maximum relative humidity of 98%. They were aged for 24, 48 and 72 hours.

3. RESULTS

3.1 Varieties Performance

There was significant variation in coleoptile formation among rice varieties ($p<0.001$), treatments ($p<0.001$) and interaction between rice varieties and treatment ($p<0.001$). The difference between all treatments was significant with 72 hours treatment having the highest number of days to coleorhiza and coleoptile formation, while 0 hours of treatment showing the earliest formation of these parts, (Figs. 1-3).

3.2 Seed Vigor

According to findings in this experiment, there was a negative relationship between seed vigour and hours of treatment when rice varieties and lines were subjected to 45 degrees temperature. Seed vigor reduced with an increase in hours of treatment. The control experiment, at 0 hours/normal germination generally gave the earliest number of days to coleoptile formation, and highest germination percent at 7, 14 and 21 days. In fact, after 48 hours and 72 hours of treatment, the mean germination at day 7 was zero, meaning there was no coleoptile or coleoptile that had formed at this time.

In general the number of seeds that germinated increased with the increase in days, and observations made on day 21 gave the highest percentages.

Coleoptile formation was significantly different at each level of seed treatment. Seeds treated for 72 hours had the latest coleoptile formation, successfully reducing with reducing number of hours in treatment.

In the 7th day of the trial, there were seeds that had been treated for 48 and 72 hours that had not germinated. The highest germination was in seeds not treated/ normal germination followed by those treated for 24 hours. At 14 and 21 days germination ranking for different treatments was similar to that at 7 days. In both cases, there was some germination in all the treatments. As shown in the graph, when percentage germination was measured at 7 days, there was no germination in treatment 3 and 4, 48 and 72 hours respectively in most of the varieties.

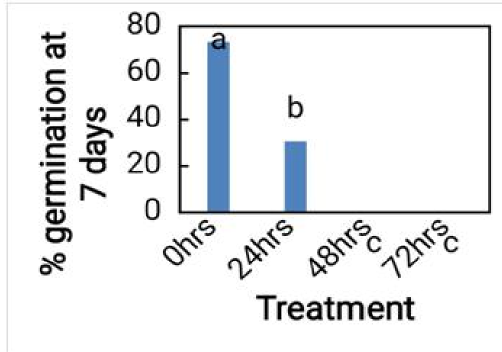

Fig. 1. Percentage germination 7 days after ageing

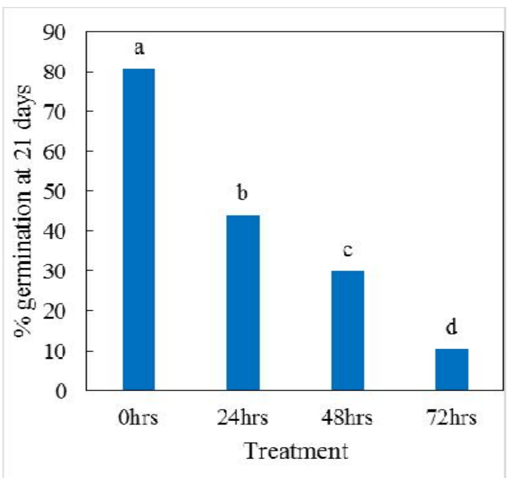

Fig. 2. Rice percentage germination 21 days after ageing

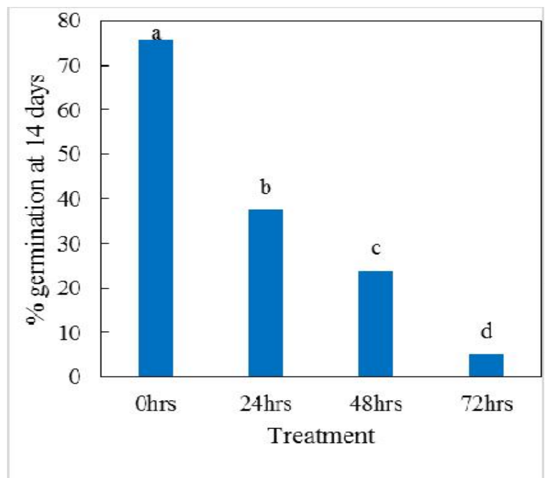

Fig. 3. Rice percentage germination 14 days after ageing

Table 1. Effect of rice ageing time on germination at 7, 14 and 21 days

Variety	Coleoptile formation	Colleoptira formation	Germination % at 7 days	Germination % at 14 days	Germination % at 21 days
0hrs	3.34 d	4.38 d	73.28 a	75.72 a	80.66 a
24hrs	6.59 c	7.91 c	30.38 b	37.5 b	44.06 b
48hrs	13.31 b	14.38 b	0 c	24 c	30 c
72hrs	16.38 a	17.5 a	0 c	5.25 d	10.44 d
Grand mean	**9.91**	**11.04**	**25.91**	**35.62**	**41.29**
s.e.	0.57	0.61	5.33	5.21	4.85
CV%	5.7	5.5	20.6	14.6	11.8
Age p value	<.001	<.001	<.001	<.001	<.001

**Means with the same letters within a column are not significantly different (LSD α =0.05)*

4. DISCUSSION

The observations from this study reveal that seed viability under accelerated ageing conditions declines with the age. According to Sun et al. [4], seed vigor is an important characteristic of seed quality, reflecting potential seed germination, seedling growth, seed longevity, and tolerance to adversity.

Foolad et al. [5] also indicated that high vigor seeds result in increased germination and uniform stand seeds with strong vigor may significantly improve the speed and uniformity of seed germination. The result is an excellent field emergence, good crop performance, and increased yield even in varied conditions. Seed vigor reflects damage that accumulates as viability reduces especially in relation to moisture and temperature and may finally cause death of seed.

The present study has shown that prolonged duration of higher temperatures results in a reduction of seed viability higher temperatures instead of causing stress can promote protein denaturation and seed death. These results agree with the findings and publications of *Seed Technology* © 2001 where both treated and untreated maize seed aged at 45°C showed significant reductions in germination after 72 hours. Seed vigor has been known as a comprehensive characteristic affected by many factors, such as the genetic background, environmental factors during seed development, and storage stages according to [6,4]. Temperature is and the environmental condition that is key in the storage of seeds and other plant materials of rice and most crops. A publication by Hampton and TeKrony [7] also performed an experiment to optimize temperatures for accelerated ageing tests in paddy rice using 30°C to or and 50°C, the relative humidity of 50 and 90% and aging period 3 to 14 days to accelerate the ageing process [8,9].

Further observations from the study revealed that storage duration or the time taken to store seeds has a negative correlation to the viability of rice seeds. The seeds that were aged for 24, 48 and 72 hours had a decrease in viability. However, it was worth noting that seeds stored for a longer time may be given more time to improve on the percentage germination since their speed of germination is generally low. Thus it was noted that although at 7 days after sowing a number had not germinated, when observations were made after 14 and 21 days, the performance was improved. Studies on germination and vigor could, therefore, be extended further than 7 days to check performance.

Seeds with strong vigor may significantly improve the speed and uniformity of seed germination and the final percentage of germination, and lead to perfect field emergence, good crop performance, and even high yield under different conditions.

Generally, seed quality is a factor of the Species, cultivars, purity, germination, vigor, health, temperature and moisture). Good and healthy seed marks a giant start to nursery establishment for transplanting field, and uniform field establishment for the direct planted field, all serving as a driving force to yield.

5. CONCLUSION

Vigor tests are important and necessary in order to obtain a clearer picture of the actual performance of rice in field conditions. Storage period affects vigor of most seeds. It is, therefore, necessary that the length of storage of seed be controlled to minimize damages. The temperatures for storage environment should also be optimized.

The present research has shown that there is actual variation in vigor of seeds of different varieties which results in a variation of field performance later on. Basmati variety the need to improve irrigated rice varieties is important in enhancing productivity.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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