



Rice Seedling, Vegetative Growth and Vigour as Influenced by Seed Storage Period

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ABSTRACT

*The main problem affecting productivity involves lack of proper information on best storage time, use of poor quality seed, varietal admixtures which has contributed to low yields. The study assessed the effects of storage on seedling characters of rice in Kirinyaga County. Five varieties were used to produce seedlings after storage for 1,2,3,4,5 and 6 months respectively. The seedlings were transplanted into fields in a Randomized Complete Block Design using 5*6 factorial arrangements. Data was collected on root length, shoot length, germination, tillering, days to 50% flowering date, plant height at maturity, blade length and blade width. All the data were analyzed using GENSTAT statistical package add version and copyright host organization, and means separated using Fisher's Protected LSD at 5% significant level. There was a significant effect of storage time on germination, with 4 months giving the highest seedling vigor index (673.6), height at 1 month after transplanting (73.3cm), height at maturity (72.3cm) and 3 months giving the highest days to flowering (58.87). The interaction between storage time and genotype on was significant, with genotype B217 stored for 3 months leading in height at one month after transplanting (87.7), height at maturity (91.8cm). The present study indicates that interaction between storage time and variety has an effect on seedling growth.*

Key words: Rice Seedling, Vegetative Growth, Vigour, Seed Storage Period

INTRODUCTION

Rice belongs to the genus *Oryza* and has two species cultivated throughout the globe: *Oryza glaberrima*, whose other name is African rice, and *Oryza sativa*, also commonly referred to as Asian rice (Lanares, 2002). Rice is a vital cereal in supplying higher than 20% of calories used globally in the human diet and serves as a staple cereal to more than fifty percent of human beings in the globe. With reference to energy consumed in the world, rice gives 20%, wheat 19% and maize gives 5% (FAO, 2009). There are two cultivated rice species, *Oryza sativa* and *Oryza glaberrima*. The most commonly cultivated species in Kenya is *Oryza sativa*. The production of rice in Kenya has faced several challenges, which results in low yields that include diseases, pests, prolonged seed storage (African Rice 2013).

Seed storage period can be classified as long term, short term or medium. Good storage maintains the quality of seed for example; storage in air tight conditions has been found to be useful in maintaining initial moisture content and prevents thriving of insects and pests. The viability of seeds stored in open conditions in the tropics rarely exceeds 2 years.

Africa produced an average of 14.6 million tons of rough rice per year on 7.3 million hectares between 1989 and 1996 (Traore, 2005). Out of the vast available areas, West Africa has the largest planted rice area of about 4.1 million hectares. Yet, production remains at low levels. This is probably due to poor crop management techniques, lack of research and extension system, and limited utilization of productive varieties (Badawi, 2004; Anon,



2007). One of the major concerns in rice production has to do with seed and grain quality (Traore, 2005). Seed quality can be considered as the summation of all factors that contribute to seed performance (Rickman *et al.*, 2006). These factors can be grouped as genetic, physical, and physiological quality.

The length of time that a specific seed takes in storage is genetically determined though the prevailing conditions may lengthen or shorten this period. The storage preservation substances are genetically ingrained within the seed (Delouche, 2016). The seed remains of good quality within the predetermined period. Beyond this stage, the seed deteriorates. Seed deterioration is defined as irreversible damage to the viability qualities. The process can only be slowed to avoid huge losses (Delouche, 2016).

The process of growing an embryo into a seedling, that is, seed germination entails having the metabolic pathways being reactivated resulting the plumule and radicle growing (Black and Halmer, 2006). The initial phase of growth of the plant is the seedling establishment. The last stage is characterized by the seedling emerging above the surface of the soil. To determine the percentage of germination both the seedlings that are normal and abnormal are counted on the tenth (Richman *et al.*, 2006). A normal seed has all structures that are very necessary of a seedling as it develops whereas abnormal seeds do not have essential structures such as the cotyledon despite germinating during the test period (Schmidt, 2000).

Best quality seeds result in best quality crops subsequently yielding highest value yields (Mbora *et al.*, 2009). The quality of the seed is of great value to the farmers as it enables them to determine the seed potential performance when subjected to conditions that are optimal. High-quality seeds are expected to produce seedlings which are healthy and do not have any initial disease traits because the high-quality seeds tend to be better in health and are free from many diseases

The description of Li (2003) illustrates that the rice grains are coarse or paddy, comprising brown rice (or caryopsis) and the hull. The brown rice consists of three major parts. These include the embryo, the endosperm, and layers (usually thin) of differentiated tissues. These layers are the pericarp, the five nucleoli and the seed coat. According to Li (2003), the seed coat has six layers of cells. The aleurone layer occupies the mid-center of all the layers. The embryo, on the other hand, has the plumule (referred to as embryonic leaves) covered by coleoptiles and the radical or embryonic root unsheathed by the coleorhizae. The plumule and the radical are joined by the mesocotyl (Li, 2003). Rice endosperm chiefly consists of starch granules in a proteinaceous matrix, fused with sugar, fats, crude fiber and organic matter.

Hull weight contributed to about 20% of the total grain weight. Some rice grains have hulls with three parts namely: rachilla, lemmas, and palea. Others possess rudimentary glumes whereas others have a unique portion referred to as the pedicel within their structures. A perfect understanding of grain quality demands a careful study of the physical structure of each grain. It begins with observing the anatomy of a single grain irrespective of the purpose that the grain may serve ultimately (Hammermeister, 2008). The study is required especially in grading of grains meant for human consumption.

From seed germination, several plants go through a level of growth and development which enables them to shift to final yielding stage. One way to account for the low productivity in



rice is to study the growth stages and correlate the juvenile characters to adult characters and yield. There are three distinct phases of growth that can be discerned including juvenile vegetative phase, an adult vegetative phase, and an adult reproductive phase (Lawson and Poethig, 1995; Sylvester *et al.*, 1996; Kerstetter and Poethig, 1998). The phases occur in a distinct manner where the change from across the phases may be sudden or gradual (Hackett, 1985; Sylvester *et al.*, 1990; Greenwood, 1995; Bongard-Pierce *et al.*, 1996).

Distribution of rice

The origin of rice cultivation remains parts of Africa and Asia. In Asia, the more evidence shows that Southwest regions such as Eastern India, Southern and Indo China are the most likely areas that the crop might have originated. The main rice growing regions are found in Africa, Latin America, and, Asia though the major exporting countries are Thailand, the United States, Pakistan, Vietnam and India (Boumas, 1985). It is claimed that not all the rice produced in these regions are fit for human consumption. However, a larger percentage (85%) is used for human consumption as the rest as channeled to other uses. Li, (2003) observed that Antarctica is the only continent in the world which does not produce rice. Another recent study estimated by De Datta (1981) listed some 112 rice-growing cross the globe. Three international research centers are currently working on studies regarding the extensive distribution of rice (De Datta, 1981).

Despite the rate at which seeds germinate varying from the various seed varieties upon the first leaf and root shooting in the very first five days after planting then the seed is said to have sprouted (Rickman *et al.*, 2006). Crop establishment is determined by a germinating seed being able to grow and survive. The fast growth of seedling when subjected to field conditions with the potential of the seedling to grow variedly in relation to background environment and genes is the seedling vigor (Qun and Sun, 2007).

There arises variation between seeds and their respective vigor from varied factors of which affect the seed. The arising variations are as a result of seed lots maturity at the time of harvest, the pattern of growth of the plant and the post-harvest handling. Despite seed vigor determination by the conditions of the environment during its maturity both the pre-harvest and post-harvest storage and handling may equally influence it (Nerson, 2007). Various factors in the environments onto which the plant is subjected to as it grows affect the end product in relation to its germination and vigor. The moisture content of the seedling vigor affects the speed with which the seedling emerges evidenced by seedling emergence being faster at a moisture content of less than 20% during harvest.

Rice production

A large population of the world consumes rice. It is the second most crucial cereal after maize in the world today. Of the cereals, rice is the second most commonly consumed. Its popularity can be because it is very easy to digest. More than 90% of the rice grown and consumed worldwide happens in the Asian communities. Li (2003) states that approximately 155 million hectares are used globally to produce rice amounting to 596.5 million metric tons annually. Most people prefer rice over other food crops. The preference rate, however, vary from one region to another (Juliano, 1993).



METHODOLOGY

Experimental design and treatment coding

A completely random block design with 3 replications was used and plot area was 6m². The arrangement was a 5by6 factorial design including 5 varieties and 6 storage levels. The plot sizes were 3m× 2m. Each of the 3 blocks had 30 plots giving a total of 90 experimental plots the spacing was 20cm within rows and 20cm between rows, the total plant population was 100 per plot

Table1: Coding of the treatments

Code	Treatments
Storage time (Months)	
M1	1 month old seeds
M2	2 month old seeds
M3	3 month old seeds
M4	4 month old seeds
M5	5 month old seeds
M6	6 month old seeds
Genotypes	
V1	J54
V2	J64
V3	B370
V4	B217
V5	Pishori

Nursery and Transplanting

The seeds were soaked in water for two days prior to sowing to aid in breaking seed dormancy, Seeds were first planted in a nursery according to IISTA Standards and were sown at hill space of 20 cm×20 cm with one plant per hill. These seedlings were transplanted in experimental blocks and various juvenile growth characters were observed. Juvenile characters include number of leaves per plant, height, days to flowering, number of tillers per plant. The seedlings transplanted in a randomized complete block design replicated thrice. The plots were hand weeded and kept weed free up to harvesting.

Temperature and rainfall variation

Average ambient seed storage temperature was 21.3°C (± 6.3) ranging from a high of near 30°C to a low of about 7°C. Mean humidity for ambient storage was 73.7% (± 8.3) ranging from a high near 90% to a low near 30%. All seed lots for all species were stored in the same ambient storage and exposed to the same ambient conditions.

Data collection

Data was collected on seedling vigor, root length, shoot length, germination), tillering characteristics, days to 50% flowering date, plant height at maturity. Measurements were taken on leaf dimensions were recorded by measuring blade length, blade width at the widest point. 10 plants were sampled.



RESULTS AND DISCUSSION

The storage time had a significant effect on the percentage germination ($P < 0.05$). Seeds planted after 5 months of storage gave the highest percentage germination.

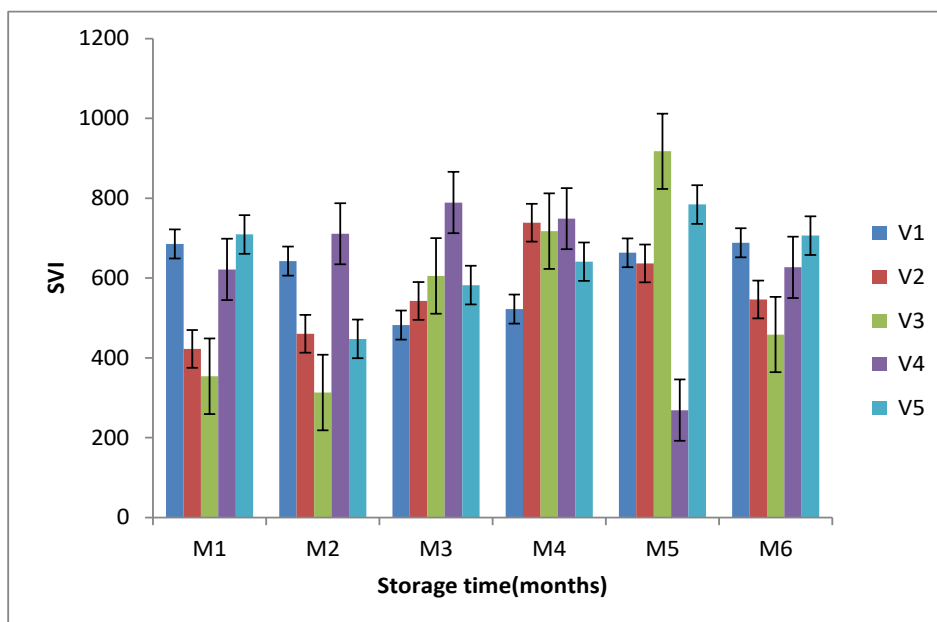


Figure 1: Interaction of storage time x genotype interaction on germination

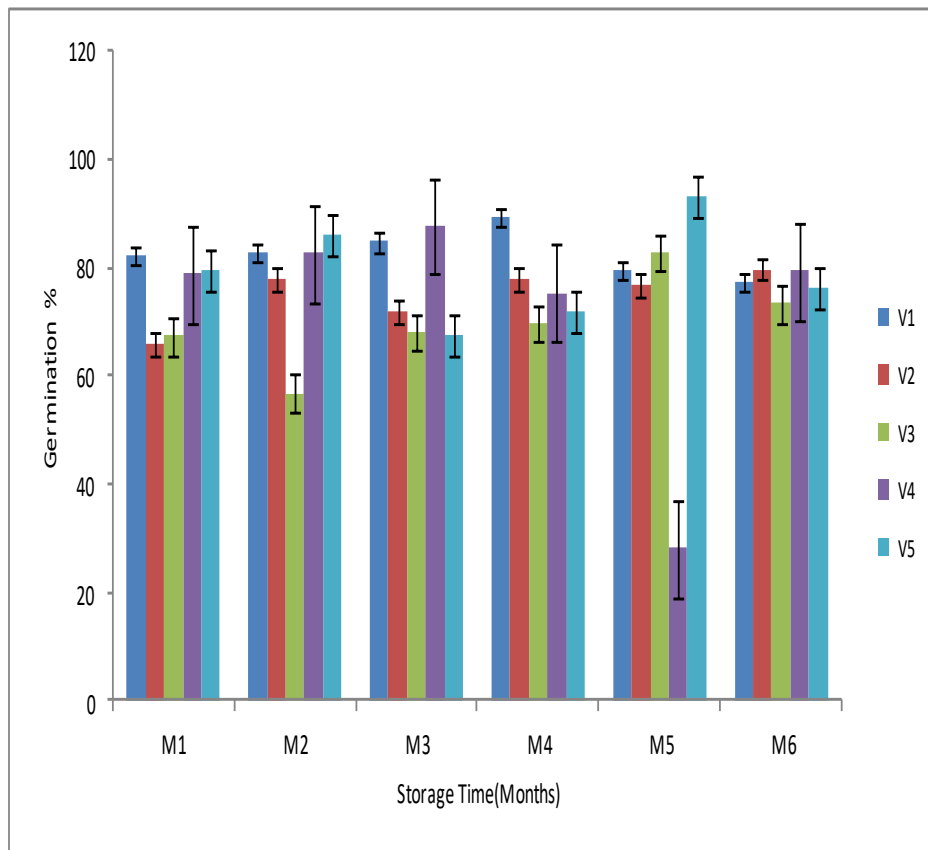
Key: V1=J54, V2=J64, V3=B217, V4=B370, V5=Pishori, M=month

Seeds planted after six months of storage gave the lowest germination percentage (71.67). The storage time had a significant effect on the seedling vigor index ($P \leq 0.05$). Seeds planted after four months of storage gave the highest mean seedling vigor index (673.6) while seeds planted after two months of storage gave the lowest seedling vigor index (514.7).

The storage time had a significant effect on the height of plants measured at transplanting stage ($P \leq 0.05$). The tallest plants were obtained from seeds planted after six months of storage (24.4) while the shortest heights were obtained after 4 months of storage (16.8). The storage time had a significant effect on the height measured at 1 month after trans-planting ($P \leq 0.05$). The tallest plants were obtained from M4 (73.3) while the shortest were obtained from M2 (58.4). The storage time had a significant effect on the height measured at two months after transplanting ($P \leq 0.05$). The tallest plants height was obtained from M5 (66.3) while the shortest plants were obtained from M3 (55.2). The storage time had a significant effect on the height measured at maturity ($P \leq 0.05$). The tallest plants height was obtained from M4 (72.3) while the shortest plants height was obtained from M6 (65.5).



The storage time had no significant effect on the panicle length ($P \geq 0.05$). Genotype had no significant effect on panicle length ($P \geq 0.05$). There was no significant interaction between



genotype and storage time on the panicle height ($P \geq 0.05$). The storage time had a significant effect on the number of days to flowering ($P \leq 0.05$). Seeds planted after three months of storage flowered early (58.99) while those planted after six months of storage flowered latest (94.76).

Figure 2: Interaction of storage time x genotype interaction on Seedling Vigor Index

Key: V1=J54, V2=J64, V3=B217, V4=B370, V5=Pishori, M=month

The time of storage had no significant effect on the number of spikes produced by the rice genotypes ($P \geq 0.05$). There was no significant effect of the genotype, storage time or genotype x storage time interaction on the length of leaves at maturity ($P \geq 0.05$). There was no significant effect of the genotype on the width of leaves at maturity ($P \geq 0.05$).



Table 2: Effects of Storage time on growth parameters of Rice at Mwea

Storage time	Germ %.	Height cm	Height cm	Height cm	Length cm	Seed VI	Days Flowering	No. of Tillers	Leaf length gth	Leaf width dth
		16.75	63.0	64.06b	7.52	558.			29.	0.9
M1	73bc	e	5bc	c	d	4d	72.0c	7.9c	95	5
	73.93b	19.09	58.3	63.23a	7.04	514.			31.	0.9
M2	c	d	6c	b	d	7e	64.5d	8.7bc	56	5
	73.47b	17.21	56.8		8.14	600.			28.	0.9
M3	c	e	7c	57.15c	bc	0c	58.9e	11.4a	42	3
	75.93a	20.15	71.1		8.59	673.			25.	0.9
M4	b	c	9a	72.3a	b	6a	73.0c	9.7abc	23	4
		21.35	68.7			653.			30.	0.9
M5	71.67c	b	8ab	66.3a	9.2a	9b	81.9b	8.9bc	06	5
		24.38	64.1						30.	0.9
M6	78.4a	a	bc	66.5bc	8.1c	605c	94.7a	10.2ab	7	5
P										
value					0.00				0.2	0.9
e	0.001	0.001	0.01	0.001	1	0.01	0.001	0.004	6	0
LS						16.5			5.5	0.0
D	3.6	0.99	7.54	5.2	0.52	9	2.7	1.8	2	6

Values followed by the same letters within the column are not significantly different (LSD α =0.05)M-Month

DISCUSSION

Results from the study agree with those of Abeshaw, (2013) on an experiment on the effect of storage and varieties on quality, growth and yield of Tef *Eragrotis Tef* (Zucc) also confirmed that seed vigour index and seedling length were affected both by Genotype and seed storage period. The change of temperature, photoperiod, or nutrient or drought stress, during seed development, maturation, and after dispersal, may strongly affect seed performance (Donohue, 2009). Glaucia et al. (2009), in an experiment assessing the storage of sorghum seeds harvested at different moisture levels found that as harvest proceeded with greater moisture contents, the physiologic quality of these seeds decreased; seed physiologic quality decreased significantly. The change of temperature, photoperiod, or nutrient or drought stress, during seed development, maturation, and after dispersal, may strongly affect seed performance (Donohue, 2009).

Sun et al. (2007) defined seed vigor as a quantitative trait that is affected by many factors, and that vigor is measured through individual traits among which are germination, seedling length, root length, seedling fresh weight, and seed longevity. The results observed in this study reinforce those of Corte et al. (2010) and Nakada et al. (2010), who noted an increase in lipid peroxidation with increasing deterioration of the seeds. Thus, the reduced activity of catalase can make the seeds more sensitive to the effects of free radicals and enhance peroxide formation in cells, making the seeds more subject to loss of viability.

In several studies, significant relationships have been observed between loss of viability and decreased activity of this enzyme. In wheat seeds artificially aged, Ganguli and Sen-Mandi



(1993) showed that the enzyme α -AM was synthesized in reduced rates by aleurone layer. According to the authors, deteriorative changes may occur in the aleurone layer during aging (Timóteo and Marcos-Filho, 2013). These changes may determine the decrease in amylase production which in turn affects the germination. This was verified through vigor tests. Where the seed performance was reduced during storage.

One of the characteristics of varieties with a wide adaptation is that the seed of these varieties has good physiological characteristics and is still suitable for planting after long storage under not too favorable conditions (Govindarasu et al. 2000).

CONCLUSION AND RECOMMENDATION

The effect of storage time on performance of juvenile growth characters was significant with three and four months exhibiting highest results with respect to seedling vigor index and height at transplanting. The study recommends that seed be stored for a short period of 3-4 months before planting based on particular genotypes. Prolonged storage beyond this may result in poor growth performance and poor stand in the field.

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