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Response of Seed and Seedling Vigour on Field Establishment of Upland Rice Varieties

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ABSTRACT

Rice production is at the increase throughout the world. There are few research about varietal differences for seedling vigour and field establishment of upland rice, this study was conducted in a randomized complete block design in four replications. Seven varieties of upland rice were used, seed vigour tests, Accelerated ageing tests, Conductivity test, Standard germination tests, field emergence test and conductivity test, were carried out. Analysis of variance showed significant difference among the Varieties, the correlation result indicated that accelerated ageing test is the best indicator that predicting field emergence. Regression analysis showed the traits that are best quantify for seedling vigour and field establishment.

Key words: *Rice*, Cultivation, *Seedling, Varieties*

INTRODUCTION

Rice (*Oryza sativa* L.) belongs to the grass family Poaceae, of the genus *Oryza* in the tribe *oryzae*. *Oryza sativa* is one of the most important cereals in the world, with a global production of 590 million tons. Rice is a prominent source of carbohydrate in the food basket of most countries, including Nigeria. Rice is relatively easy to produce, and it is grown for commercial purpose and home consumption. Cultivation of rice in Nigeria is practiced virtually in all parts of the country, from the mangrove of the Niger Delta to the dry zone of the north. Potential land area suitable for rice production is about 5 billion hectares, out of which, only 1.8 million hectares is presently cropped[8].

Despite the contribution of Nigeria towards rice production, the average yield as compared to other countries is much lower[18]. The average yield is often less than 2,000kg/ha which is much less than other countries like Egypt (8,250kg/ha), Asia (5,000kg/ha) Australia (8,230kg/ha), USA (6,740kg/ha) and China (6,170kg/ha) as reported by Duwayri *et al*[5].

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Rain-fed upland rice is a major crop of importance in sub-Saharan Africa (SSA) where it accounts for over 40% of the land under rice cultivation[20]. It has increasingly become popular amongst first time rice growers in non-traditional rice producing regions of SSA like Nigeria[12].

Improved upland rice cultivars introduced to Nigeria have been widely adopted by farmers are being grown as a cash crop because of their preferred long slender grain and high market price similar to that of high quality imported rice. However, one of the major constraints limiting the production in upland rain fed system is the poor seeding emergence stand establishment due to low germination capacity, which may result from pre-emergence death of seedling. Pre-emergence death of seedlings directly affects yield by reducing plant population. In addition, delayed or non-uniform emergence may be a yield reducing factor[9].

Emergence ability or seedling vigour is a function of seed quality and genotype[16]. For instance, seed produced in a year with favourable growing conditions will produce more vigorous seedling than seed produced during stressful growing seasons. Similarly, seedlings from seeds stored for a long time under unfavourable storage condition will have lower vigour[11]. Moreover, seedling vigour has been shown to vary among genotypes. It is genetically controlled and modified by the environment[13]. Early investigation and on-farm production of rice seeds have called attention to low germination and poor seedling establishment among the problems being faced by farmers. Seedling vigour is an important factor in obtaining good stand and should be an important consideration in rice seed production research. Low seed vigour has been identified as the factor mostly responsible for poor germination and uneven seedling establishment [6]. Poor emergence, low seedling vigour and poor field establishment are associated with cereal crops, cumulating in low yield. This study were to determine the variability in seed and seedling vigour of upland rice varieties, investigate the relationship between seed vigour and field performance and identify the best traits for quantifying seedling vigour and field establishment.

MATERIAL AND METHODS

Seven varieties (NERICA 2, FARO 55, FARO 58, FARO 59, FARO63, ART 15 and ART 16) of upland rice were used for the experiment at the Seed Science laboratory and Research Field of Department of Crop Production and Protection, Obafemi Awolowo University, Ile-Ife in 2016. The experiment was laid out in a randomized complete block design (RCBD) with four replications in a 0.2m × 0.5m spacing. Herbicide, fertilizer and weed control was applied according to recommendations. Standard Germination, conductivity and accelerated ageing was done in the laboratory. Standard Germination Test for obtaining germination percentage (G %), germination index (GI), and germination rate index (GRI), was carried out according to the method outlined by Fakorede and Agbana[7] Emergence counts (emergence percentage (E%), emergence index (EI) and emergence rate index (ERI))at five to ten DAP were observed. on mesocotyl length (LM), shoot length (SL),Shoot length in the field (SLF), Plant height (PH), root number (RN), Spikelet per panicle (SPP), grain weight (GW), and root length (RL) and; fresh weight (FW) of Five randomly selected plants and dry weight(DW) were obtained, dry weights of the samples were recorded to the nearest milligram, using an electronic sensitive scale. From the dry weights, growth rate (GR) and relative growth rate (RGR) were calculated for each plot.

Dry matter accumulation, growth rate, and relative growth rate were carried out using the following formulae, and regression analysis was done to determine the rate of changes

$RGR = (In\ W_2 - In\ W_1) / (t_2 - t_1)$

Where In = natural logarithm, t_1 =time one (in days), t_2 = time two (in days)

W_1 = dry weight of plant at a time one (in grams), W_2 = dry weight of plant at a time two (in grams).

Accelerated Ageing per cent (AA%) was done by pouring Forty millilitre of distilled water inside each ageing box having a suspended wire mesh inside . Fifty seeds were placed on the mesh after initial weight had been taken and the boxes were covered. These ageing boxes were labelled and kept inside the Accelerated Ageing chamber at 43^0C for 72 hours. The accelerated ageing boxes were removed and cooled at room temperature. The seeds were subjected to germination test. Fifty Seeds of all the varieties were used to carry out conductivity test (CND) according to methodology described by Vieira and Krzyzanowski[19].

Statistical Analysis

Data collected were subjected to analyses of variance (ANOVA) and significant means were separated using Fisher's least significant difference (LSD). Regression analysis was on growth rate (GR) and relative growth rate (RGR) data while Correlation was carried out on seedling vigour test and yield components data. The analyse was done using SAS version 9.2[14].

RESULT AND DISCUSSION

Mean squares for variety were significant for G%, GRI, E% and ERI (Table 1). The coefficients of determination R^2 values ranged from 52.57 to 75.93%. Emergence percentage and emergence rate index had higher coefficient of variation (CV) values than germination index and germination rate index. Mean square due to variety was highly significant among varieties for accelerated ageing percentage. The Coefficient of variation (CVs) associated with the vigour tests (accelerated ageing and germination tests) ranges from 4.36 to 19.51%. The model used accounted for coefficient of determination (R^2) of over 60% variation for accelerated ageing percentage (Table 1).

Accelerated ageing test (Accelerated percentage (AA%), Accelerated Aging Index (AAI), Accelerated ageing rate index (AARI) was lower in FARO 55 than all other varieties while the other varieties were not significantly different from each other (Table 2).

Ranking of the various varieties for standard germination test, accelerated ageing test and field emergence showed that some varieties performed the same way in the laboratory and on the field, while Art 15, FARO 58 and Art 16 performed better with their RSI ranging from 12-15 (Table 3). Similar result was obtained from Suraj-Chhetri where ageing condition of 44^0C for 72hrs. According to Ali *et al.*[1] germination of rice varieties in low temperature is influenced by genotype than seed quality.

There was a significant positive regression between germination index and emergence index (Table 4). Also, accelerated ageing percentage regressed positively with seedling fresh weight, seedling dry weight, growth rate and relative growth rate. Accelerated aging rate index was positively regressed with growth rate. Conductivity test positively regressed with dry weight (Table 4). Accelerated ageing percentage was significant positive correlate with root number and root length on the field. Shoot length was significant positive correlate with spikelet per panicle and one-thousand total grain oven-dry weight, spikelet per panicle significant positive correlate with one-thousand total grain oven-dry weight (Table 5). Studies by Bastians *et. al.* [3] showed that early vigour scores of rice cultivars under field conditions were consistent with the total plant dry weight and leaf area of plant.

The field trait coefficient of variability was generally higher than the laboratory test coefficient of variability for all traits except for plant height. Similar trend was reported by Berry *et.al.*[2] for *Vigna anthelmintica*; Gupta and Godawat[10], Satapathi *et.al*.[15] for linseed and Baye[4] for *Vigna.galamensis.* This suggests that environmental effects constitute a major portion of the total phenotypic variation in some traits.

From the results of this research, it can be concluded that the use of accelerated ageing test in predicting field emergence instead of standard germination test could help in maintaining seed viability and vigour in field and storage.

Table 1: Mean squares and other statistics of germination test, accelerated ageing and emergence traits of seven upland rice varieties

		Mean Squares								
Sources of Variation	DF	G%	GI	GRI	E%	EI	ERI	AA%	AAI	AARI
Rep.	3	61.10	0.35	0.36	271.35	0.56	10.26	267.95	2.744	3.75
Variety	6	121.81**	0.26	1.46**	557.93*	0.14	40.41*	1014.00**	3.31	29.63
Error	18	16.09	0.12	0.23	129.23	0.13	11.11	252.73	3.90	22.61
MEAN		97.07	5.42	5.93	55.31	6.32	12.45	81.64	5.64	7.85
R^2 %		75.93	54.09	70.78	64.15	52.57	57.74	19.51	34.96	60.42
CV%		4.36	6.45	8.00	20.55	5.65	26.77	60.22	28.59	31.72

*, ** indicate significant mean squares at 0.05 and 0.01 level of probability, respectively.

G%=Germination percent , GI=Germination index, GRI=Germination rate index, E%= Emergence percent, EI= Emergence index ERI= Emergence rate index, AA%=Accelerated ageing Percentage, AAI=Accelerated ageing index, AARI= Accelerated ageing rate index, R^2=Coefficient of determination, CV= Coefficient of variation

Table 2: Mean Comparison of germination test, accelerated ageing tests and emergence traits of seven upland rice varieties

VARIETY	G%	GRI	E%	ERI	AA%
NERICA2	83.50	6.84	36.08	18.66	90.00
ART 15	98.00	5.56	69.60	9.34	81.00
ART 16	89.50	6.22	69.03	9.52	100.00
FARO 55	88.00	6.56	56.25	12.12	49.00
FARO 58	99.00	5.31	57.39	11.07	85.50
FARO 59	93.00	5.48	49.72	12.70	78.50
FARO 63	93.50	5.54	49.15	13.75	86.50
$LSD_{0.05}$	5.96	0.71	16.89	4.95	23.60

G%=Germination percent , GI=Germination index, GRI=Germination rate index, E%= Emergence percent, ERI= Emergence rate index, AA%=Accelerated ageing Percentage.

Table 3: Ranking of **means and other statistics of the vigour tests for seven upland rice varieties**

Varieties	G%	GRI	E%	ERI	AA%	Summation Index
NERICA 2	7	7	7	7	2	30
ART 15	2	4	1	1	5	13
ART 16	5	5	2	2	1	15
FARO 55	6	6	4	4	7	27
FARO 58	1	1	3	3	4	12
FARO 59	4	2	5	5	6	22
FARO 63	3	3	6	6	3	21

G%=Germination percent , GI=Germination index, GRI=Germination rate index, E%= Emergence percent, and AA%=Accelerated ageing Percentage.

Table 4: Regression coefficients of germination test, accelerated ageing tests and emergence traits of seven upland rice varieties

Seed Vigour/Field	E%	EI	ERI	FW	DW	GR	RGR
GPCT	0.54	-0.47	-0.67	0.42	0.47	0.35	0.49
GI	-0.01	0.79*	0.23	0.25	-0.18	-0.36	-0.41
GRI	-0.34	0.64	0.52	0.22	-0.27	-0.42	-0.52
AA%	0.05	-0.00	0.03	0.82**	0.79*	0.86*	0.79*
AAI	0.12	-0.04	-0.18	-0.11	-0.10	-0.10	0.05
AARI	0.15	0.11	-0.22	-0.72	-0.76*	0.74*	0.61
CND	-0.80*	-0.44	0.66	-0.83*	0.85*	-0.79*	-0.73

*, ** indicate significant mean squares at 0.05 and 0.01 level of probability, respectively.

E%= Emergence percent, ERI= Emergence rate index, Emergence rate index, Fresh weight, Dry weight, Growth rate, Relative growth rate.

Table 5: Correlation coefficients between seed vigour and field performance traits of seven upland rice varieties

	GRI	E%	ERI	AA%	SL	LM	SPP	TGODW	PH	GR	RGR	SL	RN	RL
GRI	1	-0.21	0.21	0.21	-0.75*	-0.11	-0.65	-0.65	0.04	-0.29	-0.41	-0.50	0.07	0.07
E%		1.00	-0.98*	-0.11	-0.21	-0.04	-0.51	-0.47	0.57	0.61	0.56	0.21	-0.36	-0.39
ERI			1.00	0.11	0.21	0.04	0.51	0.47	-0.57	-0.61	-0.56	-0.21	0.36	0.39
AA%				1.00	-0.25	-0.43	-0.13	-0.16	0.64	0.54	0.59	0.57	0.75*	0.86**
SL					1.00	0.61	0.85**	0.87**	-0.43	-0.21	0.00	0.21	-0.14	-0.11
LM						1.00	0.33	0.35	-0.57	-0.57	-0.41	-0.43	-0.61	-0.57
SPP							1.00	0.98**	-0.49	-0.35	-0.15	0.15	-0.04	0.16
TGODW								1.00	-0.44	-0.33	-0.13	0.20	-0.05	0.16
PH									1.00	0.89**	0.85**	0.71	0.43	0.50
GR										1.00	0.96**	0.82*	0.50	0.39
RGR											1.00	0.89*	0.48	0.44
SLF												1.00	0.64	0.64
RNF													1.00	0.82*
RLF														1

*, ** indicate significance at 0.05and 0.01 level of probability respectively.

GRI=Germination Rate Index, E%= Emergence Percentage, ERI=Emergence Rate Index, SL=Shoot length, LM= Length of mesocotyl, SPP=Spikelet per panicle, TGODW=Total grain oven-dry weight, PH=Plant height, GR=Growth Rate, RGR=Relative Growth Rate, SL=Shoot Length , RN=Root number , RL=Root length .

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