VARIETAL DIFFERENCES IN SEED PHYSIOLOGICAL QUALITY OF WEST AFRICAN RICE VARIETIES AFTER DRY HEAT TREATMENT

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ABSTRACT

The study was conducted to determine the extent of varietal differences in seed quality of 20 West African rice varieties with different genetic characteristics. Seeds of these varieties were exposed to two dry-heat temperatures (50°C and 55°C) for 0, 12, 24 and 36 hrs and thereafter seed germination, energy of germination, seedling vigour index and seedling emergence were investigated. There were distinct varietal differences in the four seed quality characters at each of dry heat temperatures and durations, implying that it is a varietal attribute. Effect of dry heat treatment on the four seed quality characters depended on dry heat intensity, duration of exposure to heat and variety. At higher heat duration (55°C at 24 and 36 hrs) all the seed quality characters were significantly ($P<0.05$) reduced compared with the control (0°C) and 12 hrs treatment that had no adverse effects. NERICA 7, ITA 321 and ITA 150 showed superior quality of seed before and after dry heat treatments and the normal dry-heat treatment for the West African rice seeds was 50°C at 12 hrs in order to maintain seed germination, energy of germination, seedling emergence and improve seedling vigour. Cluster analysis revealed that NERICA 4, ITA 321, WAB 96-1-1 and NERICA 1 were heat tolerant varieties and grouped together in group 1 while the remaining 16 varieties which were dry-heat sensitive were classified together in group II. Most of the West African rice varieties were heat sensitive. Hence, dry heat treatment should be genotype specific. There were 42% reductions in seed quality attributes when seeds of these 20 varieties were heat treated at 55°C compared to 50°C. Seed dormancy in varieties ITA 257, WAB 33-25, ITA 117 and ITA 301 was not broken with any of the dry heat treatments used and should therefore be subjected to further treatments involving inorganic and organic materials. The varieties identified with superior seed quality could be incorporated into future seed improvement programmes.

Key Words: Dormancy, germinability, heat tolerance, *Oryza sativa*

INTRODUCTION

Rice (*Oryza sativa* L.) is an important staple crop in Nigeria and indeed most countries. Though there had been a gradual increase in the production of the commodity over the past years, demand and consumption have also increased dramatically. Therefore, making sustained research on efforts towards increasing local production is very imperative (Adebisi *et al.*, 2006). Globally, rice is ranked third after wheat and maize but in Nigeria, it is ranked sixth after sorghum, millet, cowpea, cassava and yam (Fagade, 2000).

Dry heat treatment of seeds is used for two purposes. One is to control the external and internal seed borne pathogens including fungi, bacteria, virus and nematodes (Fourest *et al.*, 1990; Grondeau *et al.*, 1992; Detry, 1993). The other is to break the dormancy of seed (Zhang, 1990; Adebisi *et al.*, 2005, Ajala *et al.*, 2005). Dry heat is a convenient and effective method for large scale treatment in many crops. Breeders use dry heat treatment to break seed dormancy after drying freshly harvested rice seed from greenhouse or field. During breaking, seed moisture is important for seed viability. The safe condition for seed viability is defined in temperature ranges and treatment durations. The critical temperature for seed viability also differs according to chemical factors in the endosperm, hull and pericarp structures. Rice seed dormancy is imposed by certain physical and chemical factors associated with its covering structures, such as the hull and pericarp (Zhang, 1990). In general, the high temperature in dry heat treatment reduces seed viability and seedling vigour, but optimum temperature for breaking dormancy promotes seed germination and seedling emergence in cereals crops (Lee *at al.*, 2002).

The degree of promotion of seed germination by dry heat treatments showed a wide intra specific variation (Herranz *et al.*, 1998; Adebisi *et al.*, 2005; Ajala *et al.*, 2005). Non-lethal heat shock treatment before radicle emergence effectively promoted the germination of barley and wheat seeds (Dell-Aquila and Di-Turi, 1996; Dell-Aquila, *et al.*, 1998). In other crops, lower temperatures at (65 76°C) had no adverse effects on seed viability (Fourest *et al.*, 1990; Menga *et al.*, 1999).

Review of the literature indicates that criteria such as storage temperature, humidity, grain moisture, spectrum of fungi to be controlled, method of seed treatment, procedure, duration of storage, the rate of fungicide degradation and effect on seedling development all influence the seed quality. Most publications deal with heat treatment and foreign rice variety studies and there is little on the efficacy of pre-sowing heat treatment on seed physiological quality in the newly developed New Rice for Africa (NERICA) rice varieties of the West African Rice Development Association (WARDA). Therefore, it is imperative to evaluate the effect of dry heat treatment on modern West African rice varieties, developed from different genetic sources. This study is important with the view to developing a suitable seed management strategy for increasing establishment count in the West African rice field, thereby leading to higher yields.

The objectives of the study therefore were to determine the extent of varietal differences in seed germination and seedling vigour traits of West African rice varieties following dry heat treatment and to determine the dry heat tolerance level among the 20 West African rice varieties.

MATERIALS AND METHODS

Twenty West African rice varieties were obtained from West African Rice Development Association (WARDA) at the International Institute of Tropical Agriculture, (IITA), Ibadan, Nigeria. The varieties were newly developed New rice for Africa (NERICA) from the hybridization of *Oryza sativa* and *Oryza glaberrima*,. Nothing was known about their seed quality and being new varieties, seed dormancy has been reported with some of them.

Seeds of the rice varieties were about four week old after harvest and stored at room temperature (28.8- 30°C) for two weeks to break their seed dormancy. The 20 rice varieties were then prepared for two dry heat treatments.

100-seed batches of each variety were subjected to two different dry heat temperatures (50°C and 55°C) at different durations (12, 24 and 36 hrs). Control treatment was included (ambient temperature (28.8-30°C). All treatments were tested in a completely randomized design (CRD) with three replications. The experiment has three factors: variety, heat treatment and heat exposure duration. Heat treated seeds of each variety were assessed for seed quality thus:

Seed germination test: 100 seeds were placed on top of seed test papers in an 11 cm diameter petri dish and 10 ml of sterile de-ionized water was added. There were three replicate dishes for each lot. The dishes were placed inside incubator at temperature of 20-25°C ± 1. The dishes were inspected 4, 6 and 8 days after sowing and germinated seeds were counted (defined as those with a radicle at least 2 mm long) and ungerminated seeds at the end of the test were also counted and expressed in percentages.(ISTA, 1985).

Energy of germination (EG):

This was calculated as: $$\frac{\text{Number of seeds germinated at 4 day}}{\text{Number of seeds sown}} \times 100$$

Seedling vigour index: Seedling vigour level of each variety was calculated by multiplying percent seed germination by the average of plumule length of each variety after 8 days of germination (Kim *et al.*, 1994) and divided by 100 (Adebisi *et al.*, 2006).

Seed quality as influenced by dry heat treatment

Seedling emergence: Three 100-seed of rice replicates for emergence test was performed by sowing seeds at 2 3 cm depth in randomized blocks in pots. Percentages of seedlings at the start and the end of emergence were counted (Adebisi *et al.*, 2006)

Data Analysis

For all the experiments, analyses were performed by using the SPSS statistical software (Version 11). Means of the data were collected and analyzed using Analysis of variance (ANOVA) and significant treatment means were determined using Duncan's Multiple Range Test (DMRT) at 5% level of probability. Dry heat tolerance among the 20 varieties was classified by average linkage cluster analysis using squared Euclidean distance for similarity measure.

RESULTS

Effect of dry-heat treatment on seed germination and seedling vigour

Results from Table 1 reveal that the effects of variety, heat and time were highly significant for seedling germination, energy of germination, seedling vigour index and seedling emergence. Also, the interaction effects of variety and heat, variety and time, heat and time and variety x heat x time were highly significant for seed germination, energy of germination, seedling vigour index and seedling emergence.

Table 1: Summary of ANOVA for seed germination and seedling vigour of 20 varieties of West African rice after heat treatment for different periods

Source of variation	Df	Seed germination	Energy of germination	Seedling vigour index	Seedling Emergence
Replication	2	106.77	7.51	0.34	50.79
Variety (V)	19	17910.20**	9301.59**	53.47**	10384.72**
Heat (H)	1	7894.89**	18506.43**	78.33**	24757.28**
Time (T)	3	4866.54**	15310.58**	28.27**	12081.37**
V x H	19	496.00*	394.68**	3.14**	1127.98**
V x T	57	404.96**	466.89**	2.94**	814.12**
H x T	3	902.42**	4587.88**	28.08**	2796.28**
V x H x T	57	356.88**	189.53	2.06**	359.24**
Error	318	16.58	57.45	0.53	26.83
Total	480				

* significant at 5% level of probability; ** significant at 1% level of probability

The effect of variety and heat treatment on seed germination and energy of germination of 20 varieties of West African rice is presented in Table 2. The results show that final percentages of seed germination were different according to the degree of heat treatment. At 50°C heat treatment, ITA 321, NERICA 4, NERICA 7, and ITA 150 had the highest seed germination of between 79 and 85%, followed by NERICA 1, NERICA 2 and WAB-249-B-B-6-HB-1 with 65, 64 and 62% germination, respectively. After 55°C heat treatment, NERICA 7 and ITA 321 had the highest percentage germination of 78%, closely followed by WAB96-1-1(69%), NERICA 4 (72%) and ITA 150 (68%). In all, ITA 257, WAB 33-25, ITA 117 and ITA 301 recorded the lowest percentage germination under 50°C and 55°C heat treatments. For energy of germination, after 50°C heat treatment, NERICA 7 (73%) and ITA 321 (69%) had the highest values while NERICA 7, ITA 321 and ITA 150 recorded significant ($P < 0.05$) highest energy of germination after 55°C heat treatment. In all, ITA 257, ITA 117 and ITA 301 varieties recorded the lowest in each of the heat treatments.

The results in Table 3 show that at 50°C heat treatment, NERICA 4, NERICA 7, ITA 321 and ITA 150 had the highest seedling vigour while at 55°C treatment, varieties NERICA 4, NERICA 7 and ITA 150 exhibited greater seedling vigour index. At the end, ITA 257, WAB 33-25, ITA 117 and ITA 301 were among varieties with lowest seedling vigour at 50°C and 55°C heat treatments. In terms of seedling emergence, NERICA 4, ITA 132 and ITA 150 followed by NERICA 7 showed highest seedling emergence($P<0.05$) at 50°C which ranged from 72 81%. However, at 55°C treatments, NERICA 4 and ITA 321 followed by NERICA 1 exhibited the highest emergence while seeds of ITA 257, WAB 33-25, ITA 117 and ITA 301 recorded no emergence.

On the effect of variety and duration of heat treatment (Table 4), NERICA 7, ITA 321, ITA 150 and NERICA 4 exhibited highest seed germination of 87, 84 and 82 and 80% respectively under control treatment, Similarly, NERICA 7 (87%) and ITA 150 (84%) exhibited highest seed germination at 12 hrs heat treatment. At 24 hrs, NERICA 7 had the highest seed germination of 88%, followed by ITA 321 (79%) while at 36 hrs heat treatment, NERICA 1, NERICA 4 and ITA 321 (75 78%) had highest ($P< 0.05$) seed germination. However, ITA 257, WAB 33-25, ITA 117 and ITA 301 recorded the lowest germination percentage at each of the heat treatment period. From the same Table 4, significant differences were exhibited among the varieties in respect of energy of germination under each of the dry heat treatments. NERICA 7 (78%), NERICA 4(69%), ITA 321 (74%) and ITA 150 (69%) had greater energy of germination

Table 2: Effect of variety and heat treatment on seed germination and energy of germination of 20 varieties of West African rice

Variety	Seed germination (%)		Energy of germination (%)	
	50°C	**55°C**	**50°C**	**55°C**
ITA 257	0g	0h	0f	0d
WAB 224-B-HB	26f	17g	13e	6d
WAB 224-B-H-B	34e	28g	25d	10d
WAB 33-25	3g	3f	1f	1d
WAB 96-1-1	56c	69b	50b	38b
NERICA 1	65b	62b	45c	33b
NERICA 2	64b	36e	43c	23c
NERICA 3	53c	36e	37c	17c
NERICA 4	81a	72b	56b	41b
NERICA 6	41d	35e	29d	17c
NERICA 7	81a	78a	73a	55a
ITA 117	0g	0h	0f	0d
ITA 321	84a	78a	69a	52a
ITA 301	0g	0h	0f	0d
ITA 150	79a	68b	60b	46a
WAB 384-B-7-H2	52c	39e	39c	21c
WAB 249-B-B-6-HB-1	62b	48d	44c	20c
WAB 384-B-7-H2-1	40d	20g	19de	8d
WAB 880-1-32-1-1	30e	16g	21d	8d
WAB 337-B-B-20-H2	57c	39e	34d	18c
Mean	45	37	33	21

abc... Means followed by the same alphabets along the column are not significantly different from one another according to Duncan multiple range test at 5% probability level

under control treatment. After 12 hours of dry-heat treatment, three varieties (NERICA 7, ITA 321 and ITA 150) were identified with highest energy of germination of between 71 and 78%. With increase in dry heat temperature to 24 hours, ITA 321 (60%) and NERICA 7 (63%) recorded the highest energy of germination compared to other varieties. However, at 36 hours of dry-heat treatment, in most cases, the energy of

Table 3. Effect of variety and heat treatment on seedling vigour index and seedling emergence of 20 varieties of West African rice

Variety	Seedling vigour index		Seedling emergence	
	50°C	55°C	50°C	55°C
ITA 257	0f	0e	0f	0g
WAB 224-B-HB	1e	1d	13e	7f
WAB 224-B-H-B	2d	1d	32d	19e
WAB 33-25	1e	1d	0f	0g
WAB 96-1-1	4b	1d	36d	29d
NERICA 1	4b	2c	45c	43b
NERICA 2	3c	2c	39d	21e
NERICA 3	3c	1d	44c	35c
NERICA 4	5a	4a	75a	50a
NERICA 6	2d	1d	32d	17e
NERICA 7	5a	4a	72b	37c
ITA 117	0f	0e	0f	0g
ITA 321	5a	3b	75a	51a
ITA 301	0f	0e	0f	0g
ITA 150	5a	4a	81a	32c
WAB 384-B-7-H2	3c	2c	33d	12f
WAB 249-B-B-6-HB-1	3c	2c	43c	19e
WAB 384-B-7-H2-1	1e	1d	19e	12f
WAB 880-1-32-1-1	1e	1d	17e	7f
WAB 337-B-B-20-H2	2d	1e	42c	20e
Mean	2.5	1.6	35.2	20.55

abc... Means followed by the same alphabets along the same column are not significantly different from one another according to Duncan multiple range test at 5% probability level

germination was greatly reduced, irrespective of variety but ITA321 (36%), ITA 150 (28%), NERICA 7 (33%) and NERICA 4 (28%) were varieties with greater performance. In all, many of the varieties recorded low energy of germination regardless of heat treatment durations.

In Table 5, there were varietal differences ($P < 0.05$) for seedling vigour and seedling emergence at all the dry-heat durations. For the control treatment, NERICA 7 had the highest seedling vigour of 6.0, closely followed by NERICA 4 and ITA 150 and ITA 321 while other varieties had vigour index of less than 3.0. At dry-heat duration of 12 and 24 hours, NERICA 7 consistently recorded highest vigour values of 6.0 and 5.0, respectively compared to other varieties. However, NERICA 7 (6) followed by ITA 321 (5) and ITA 150 (5) had higher seedling vigour value at 12 hours while NERICA 4 (6) and NERICA 7 (5) followed by NERICA 1, NERICA 2, NERICA 3 and ITA 150 had greater vigour value after 24 hours of dry-heat treatment. At the highest dry heat treatment duration (36 hrs), seedling vigour values were generally low; however, ITA 321 still recorded maximal seedling vigour of 4.0, followed by NERICA 4 with 3.0 values. In Table 5, significant differences were shown among the varieties for seedling emergence in all the dry-heat treatment durations. Percentages of seedling emergence of NERICA 3 (83%), ITA 321 (86%) and ITA 150 (84%) were highest under control treatment, closely followed by NERICA 4 (75%), NERICA 7 (73%) while other varieties recorded emergence of less than 70%. At 12 hrs of heating, three varieties (NERICA 4, NERICA 7 and ITA 321) gave maximum emergence of between 67 and 70%, followed by ITA 150 with 62% emergence. After 24 hours of dry heat treatment, only ITA 321 recorded emergence of 75% while other varieties gave emergence of less than 60%.whereas at 36 hours of dry heat treatment, NERICA 1 (48%), NERICA 4 (48%), NERICA 7 (44%) had greater emergence compared to other varieties which recorded percentage emergence of between 0 and 34%.

Table 4: Effect of variety and duration of treatment on seed germination and energy of germination of 20 varieties of West African rice

Variety	Seed germination (%)				Energy of germination (%)			
	Control	12 hrs	24 hrs	36 hrs	Control	12 hrs	24 hrs	36 hrs
ITA 257	0h	0i	0j	0g	0f	0f	0f	0d
WAB 224-B-HB	52d	13h	15i	5f	25e	9e	5e	0d
WAB 224-B-H-B	48e	24f	43ef	10f	41c	17e	12e	0d
WAB 33-25	11g	0i	0j	0g	4f	0f	0f	0d
WAB 96-1-1	79b	59c	58i	55b	61b	54b	37c	24b
NERICA 1	61c	62c	57ef	75a	42c	58b	33c	23b
NERICA 2	65c	56d	38j	43d	53b	48b	21d	11c
NERICA 3	49e	37e	49d	42d	35d	28d	28b	17b
NERICA 4	80b	79b	73bc	75a	69a	47c	48b	28a
NERICA 6	56d	27f	40f	27e	49c	18e	20d	7c
NERICA 7	87a	87a	88a	57b	78a	76a	63a	33a
ITA 117	0h	0i	0j	0g	0f	0f	0f	0d
ITA 321	84a	80b	79b	78a	74a	71a	60a	36a
ITA 301	0h	0i	0j	0g	0f	0f	0f	0d
ITA 150	82b	84a	72c	58b	69a	78a	38b	28a
WAB384-B-7-H2	52d	50de	30g	49c	42c	44c	24d	9c
WAB249-B-B-6-HB-1	63c	55d	59d	44c	47c	36d	33c	13c
WAB384-B-7-H2-1	45e	28f	22h	24e	27d	12e	13e	3c
WAB 880-1-32-1-1	37f	22g	14i	17f	20e	17e	9e	12c
WAB337-B-B-20-H2	51d	50de	47e	43d	37d	34d	17d	15b
Mean	**50**	**41**	**39**	**35**	**39**	**32**	**23**	**13**

abc: Means followed by the same alphabets along the same column are not significantly different from one another according to Duncan multiple range test at 5% probability level

Effect of heat treatment and heat duration on seed germination

Results in Figure 1a show that dry heat treatment (50°C for 12 hours) significantly increased seed germination compared to other heat treatment durations but had similar effect with control treatment. Heat treatment at 50°C for 24 and 36 hrs had similar effect on seed germination of the varieties evaluated. In contrast, control heat treatment had significant higher seed germination compared to heat treatments at 55°C for 12 and 24 hrs which had similar effect. Percentages of germinability of heat treated seeds at 55°C for 36 hrs were significantly reduced compared to other treatment durations. In Figure 1b, heat treatment at 50°C for 12 and 24 hours had significant increase on seedling vigour of the rice varieties compared to control treatment whereas at higher duration of 36 hrs the vigour drastically reduced. Conversely, heat treatment at 55°C for 12, 24 and 36 hours significantly reduced seedling vigour of the rice seeds. Figure 1c shows that dry heat treatment at 50°C for 12 and 24 hrs had lower emergence compared to control treatment while heat temperature of 50°C had similar emergence with control treatment. At 55°C for 12, 24 and 36 hrs gave lower emergence compared to control while 12 hrs treatment gave higher emergence than 24 and 36 hrs heat exposure times.

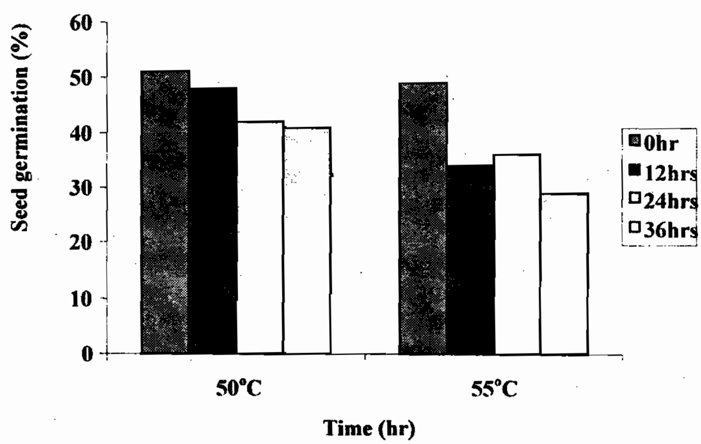
Varietal classification of dry heat tolerance

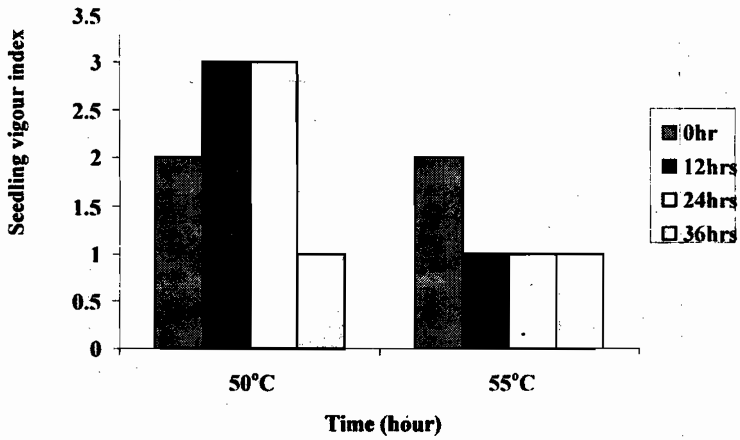
In order to compare the tolerance to dry heat treatment among the West African rice genotypes, percentages seed germination were investigated on seeds of 20 varieties subjected to 55°C for 36 hrs. As displayed in Figure 2, the varieties were classified into two groups by cluster analysis based on percentage germination. Varieties included in group I were NERICA 4, ITA 321, WAB 96-1-1 and NERICA 1 with germination of 70.75%. However, group II included 16 varieties (ITA 150, WAB 384-B-7-H2, NERICA 7, WAB 249-B-B-6-HB-1, WAB 337-B-B-20-H2, NERICA 3, NERICA 6, NERICA 2, WAB 224-B-H-B, WAB 33-25, ITA 257, WAB 224-B-HB, ITA 117, ITA 301, WAB 384-B-7-H2-1 and WAB880-1-32-1-1).

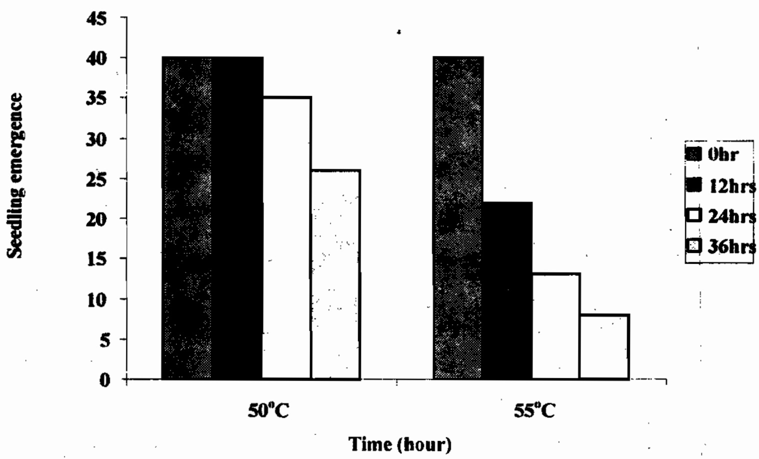
Table 5: Effect of variety and duration of treatment on seedling vigour index and seedling emergence of 20 varieties of West African rice

Variety	Seedling vigour index				Seedling emergence (%)			
	Control	12 hrs	24 hrs	36 hrs	Control	12 hrs	24 hrs	36 hrs
ITA 257	0g	0g	0e	0c	0h	0h	0f	0e
WAB 224-B-HB	1f	1f	1d	1d	16g	10g	11e	3e
WAB 224-B-H-B	2e	1f	1d	1d	56d	31d	11e	5d
WAB 33-25	1f	0g	1d	0e	0h	0h	0f	0e
WAB 96-1-1	3d	2e	3c	1d	33f	37d	33c	27b
NERICA 1	2e	4c	4b	2c	65c	40c	23d	48a
NERICA 2	3d	2e	4b	1d	57d	25e	28c	12d
NERICA 3	1f	2e	4b	2c	83a	40c	16e	18c
NERICA 4	5b	4c	5a	3b	75b	67a	58b	48a
NERICA 6	2e	1f	1d	1d	49e	20f	21d	8d
NERICA 7	6a	6a	5a	2c	73b	70a	51b	44a
ITA 117	0g	0g	0e	0e	0h	0h	0f	0e
ITA 321	4c	5b	3c	4a	86a	68a	75a	23c
ITA 301	0g	0g	0e	0e	0h	0h	0f	0e
ITA 150	5b	5b	4b	2c	84a	62b	46c	34b
WAB384-B-7-H2	3d	3d	3c	2c	20g	35d	28c	9d
WAB249-B-B-6-HB-1	3d	3d	3c	2c	52d	42c	19d	23c
WAB384-B-7-H2-1	1f	1f	1d	1d	15g	18f	25d	5d
WAB 880-1-32-1-1	1f	1f	1d	1d	20g	14f	6f	7d
WAB337-B-B-20-H2	3d	1f	1d	1d	35f	45c	26c	16c
Mean	**2**	**2**	**2**	**2**	**39.95**	**31.2**	**23.85**	**16.55**

abc.. Means followed by the same alphabets along the same column are not significantly different from one another according to Duncan multiple range test at 5% probability level







DISCUSSION

The effect of dry treatment on seed germination, energy of germination, seedling vigour index and seedling emergence depended on dry heat intensity, variety and duration of exposure to heat. Ajala *et al.* (2005) and Adebisi *et al.* (2005) had earlier reported that the influence of temperature heat treatment on seed germination and vigour of West African rice is dependent on genotype and degree of heat treatment.

Considerable variations in seed germination of ten West African rice varieties after exposure to different heat treatment were reported by Ajala *et al.*, (2005). In the present study, the 20 West African rice varieties differed in all the seed quality characters under dry heat treatment of 50°C and 55°C. Differences observed among the varieties in terms of seed germination, energy of germination, seedling vigour index and emergence could be due to variations in genetic constitution of the varieties. Okelola (2005), Adebisi *et al.*;(2006) and Okelola *et al.* (2007) had earlier reported significant differences in seed quality of West African rice. Among the varieties, NERICA 7 and ITA 321 had higher seed germination at 50 and 55°C. In all, seed germination was reduced by 18% after 55°C treatment compared to 50°C temperature. This implies that most of the varieties were sensitive to high temperature treatment. Seed dormancy observed in ITA 257, ITA 117 and ITA 301 was not broken by any of these two heat treatments.

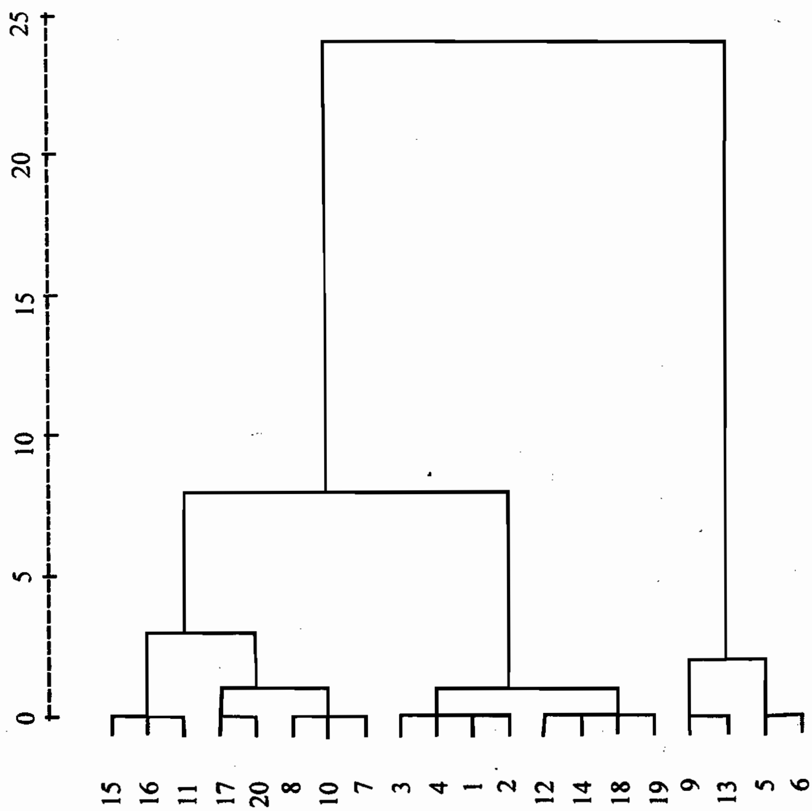


Fig. 5. Classification of West African rice varieties according to percentage seed germination in seed treated dry heat (55°C for 36) hours by cluster analysis

1=	ITA257	8=	NERICA3	15=	ITA150
2=	WAB 224-B-HB	9=	NERICA4	16=	WAB 384-B-7-112
3=	WAB 224 B.H.B.	10=	NERICA6	17=	WAB 249 B-B-6-HB-1
4=	WAB 33.35	11=	NERICA7	18=	WAB 384-B-7-H2-1
5=	WAB 96-1-1	12=	ITA117	19=	WAB 880-1-32-1-1
6=	NERICA 1	13=	ITA321	20=	WAB 337-B-B-20-H2
7=	NERICA2	14=	ITA301		

Varieties NERICA 7 and ITA 321, followed by ITA 150, WAB 96-1-1 and NERICA 4 had distinct energy of germination at 50 and 55°C. Also, energy of germination was about 12% lower at 55°C compared to 50°C, suggesting that most of the varieties were sensitive in energy of germination to higher temperature (55°C). There were distinct varietal differences in seeding vigour index and seedling emergence at 50 and 55°C temperature treatments, indicating differences in the genetic make-up for these two traits. Variety NERICA 4 and ITA 321 had distinct seedling vigour and seedling emergence at each of the heat temperatures. ITA 150 with 81% emergence at 50°C recorded a very low germination of 32% at 55°C heat intensity, revealing that this variety was sensitive to higher heat treatment.

There were significant varietal differences in seed germination at all the heat duration treatments. Varieties NERICA 4, ITA 321 and ITA 150 recorded higher seed germination at each of the heat duration except at 36 hours. This, therefore, suggest that heat temperature for 36 hours was detrimental to these varieties. However, irrespective of the degree of dry heat durations, seed germination was largely reduced in WAB 224-H-HB, WAB 224-H-H-B, WAB-33-25, NERICA 6, WAB 384-B-7-H2-1 and WAB 880-1-32-1-1. The study showed that energy of germination varied with the varieties at each duration of treatments. Varieties NERICA 7, ITA 321 and ITA 150 consistently exhibited significant higher energy of germination at all the examined heat treatment durations including control. However, seeds of the varieties recorded lower energy of germination at higher temperature duration (24 and 36 hours), irrespective of the degree of heat treatment. Similarly, significant differences were observed in seedling vigour among the varieties. NERICA 4, NERICA 7 and ITA 150 had consistent seedling vigour under each of temperature durations. Rice pre-sowing treatment had promotion tendency on seedling vigour of NERICA at 12 and 24 hours whereas, in most cases, heat treatment duration of 36 hours had reductional tendency in seedling vigour.

Significant varietal differences occurred in seedling emergence at each of heat treatment durations. Varieties NERICA 7, ITA 321 had higher emergence at 12 and 24 hrs dry heat treatment including control while NERICA 3 with good emergence before treatment was among varieties with low emergence after treatment for 12, 24 and 36 hours. Adebisi *et al.* (2005) had reported that dry heat treatments for new West African rice at 45 55°C for 24 hours improved seedling emergence level. Enhanced seedling emergence of WAB 96-1-1, WAB 384-B-7-H2 and WAB 337-B-B-20-H2 occurred at 12 hours of heat treatment using 50 55°C. In general, seeds of most of the tested varieties were sensitive to heat treatment durations with 13 to 32% reduction in emergence .when compared with control treatment.

The study demonstrated that pre-sowing dry heat treatment at 50°C for 12 hours had comparable effect with control on seed germination while other treatment durations at 50°C had detrimental effect on seed germination of these new West African rice varieties. Energy of germination of seeds of the West African rice varieties after heat treatment at 50°C for 12 and 24 hours was not significantly greater than the control, but was remarkably reduced at 36 hours of dry heat treatment. All the heat exposure times significantly reduced energy of germination at 50°C. Dry heat treatment at 50°C for 12 and 24 hours improved seeding vigour in the West African rice varieties compared to control and 36 hours. The normal dry heat treatment to improve seedling vigour of West African rice seeds is 50°C for 12 and 24 hours. In terms of seedling emergence, 50°C temperature for 12 or 24 hours did not improve seedling emergence above the control. However, dry heat treatment, at 55°C for 12, 24 and 36 hours significantly reduced seedling emergence of the rice varieties.

In varietal classification of dry heat tolerance, the 20 varieties were divided into two groups, with only 4 varieties classified into group I which are tolerant varieties while the remaining 16 varieties which are dry heat sensitive were classified together in group II. All the NERICA varieties were included in the sensitive group. In some plant species, tolerance to heat showed a wide intra specific variation (Herranz *et al.*, 1998 and Lee *et al.*, 2002).

In conclusion, dormancy can create a problem in seed analysis of rice since most of the West African rice varieties were heat sensitive. Hence, dry heat treatment should be genotype specific.
In this study, the dry heat treatment of 50°C for 12 or 24 hours may be generally safe for seed treatment of West African rice. NERICA 7, ITA 321 and ITA 150 showed superior quality of seed before and after dry heat

treatments. These varieties could be incorporated into future seed improvement programme. Seed dormancy in varieties ITA 257, WAB 33-25, ITA 117 and ITA 301 was not broken with any of the treatments used and should therefore be subjected to further treatments as well as use of botanical materials.

REFERENCES

Adebisi, M. A., Ajala, M. O., Daniel, I. O. and Fasan, K. O. (2005). Pre-sowing treatment for improving seed quality in West African rice, varieties II. Seedling emergence and seedling growth. *Nigerian Agric Journal.* 37:159-167.

Adebisi, M. A. Oyekale, K. O. , Akintobi, D. C. and Abdul-Rafiu, A. M. (2006). Variation in seed quality of West African rice (*Oryza sativa* L.). *Proceeding of the 31st Annual Conference of Genetic Society of Nigeria.* Pp67-71.

Ajala, M. O., Adebisi, M. A. and Fasan, K. O. (2005). Pre--sowing treatment for improving seed quality in West African rice varieties. I. Seed germination and vigour. *Nigerian Agric Journal* 37: 133-142

Dell'Aquila, A. and Di-Turi, M. (1996). The germination response to heat and salt stress in evaluating vigour loss in aged wheat seeds. *Seed Sci and Technology* 23: 551-561.

Dell'Aquila, A. Corona, M. G. and Di-Turi, M. (1998). Heat-shock proteins in monitoring ageing and heat induced tolerance in germinating wheat and barley embryos. *Seed Science Research*, 8: 91-98.

Detry, J. F. (1993). Seed dry-heat treatment against transmission of *Pseudomonas fuscovagivae*, causal agent of bacterial sheath brown rot of rice (BSR). *International Rice Research Notes* 18: 27-28.

Fagade, S. O. (2000). Yield gaps and productivity decline in rice production in Nigeria. *Int. Rice Comm/FAO* 15pp.

Fourest, E., Rehms, L. D., Sands, D. C. Bjarko, M. and Lund, R. E. (1990). Eradication of *Xanthomonas campestres* Pv. Translucent from barley seed with dry heat treatments. *Plant Disease* 74: 816-818.

Grondeau, C., Ladonne, F., Fourmond, A., Poutier, F. and Samson, R. (1992). Attempt to eradicate *Pseuclomonas syringae* pv. Pisi from pea seeds with heat treatments. *Seed Sci. and Technology*, 20: 515-525.

Herranz, J. M., and Ferrandis, P. and Martinez, S. J. J. (1998). Influence of heat on seed germination of seven Mediterranean leguminoseae species. *Plant Ecology.* 135: 95-103.

International Seed Testing Association (ISTA) (1985). International rules for seed testing. *Seed Sci. and Technol.*, 13: 322-326.

Kim, S. H., Choe, Z. R., Kang, J. H., Copeland, L. O. and Elias, S. G. (1994). Multiple seed vigour indices to predict field emergence and performance of barley. *Seed Sci. and Technol.* 22: 29-68.

Lee, S. Y.., Lee, J. H., Kwon, T. O. (2002). Varietal differences in seed germination and seedling vigour of Korean rice varieties following dry heat treatment. *Seed Sci. and Technol.* 30: 311-321.

Menga, S. C., and Kong, X. H. (1999). Effect of dry heat treatment on seed vigour of raddish seeds. *China Vegetables.* 3: 20-22.

Okelola, F. S. (2005). Variation and relationship between seed vigour and yield in rice (*Oryza sativa* L.) *M. Agric. Dissertation*, Department of Plant Breeding and Seed Technology, University of Agriculture, Abeokuta, Nigeria. 87pp

Okelola, F. S., Adebisi, M. A., Kehinde, O. B. and Ajala, M. O. (2007). Genotypic and phenotypic variability for seed vigour traits and seed yield in West African rice (*Oryza sativa* L). *The Journal of American Science* 3 (3). 34-41

Seshu, D. V. and Dadlani, M. (1991). Mechanism of seed dormancy in rice. *Seed Science Research* 1: 187-194.

Zhang, X. G. (1990). Physiochemical treatments to break dormancy in rice. *International Rice Research Newsletter*, 15: 22