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Evaluation of Upland NERICA Rice (*Oryza sativa* L.) Genotypes for Grain Yield and Yield Components along an Altitude Gradient in Southwest Ethiopia

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Abstract: Field experiments were conducted during the main rainy seasons of 2009 and 2010 at three rainfed upland locations of Southwest Ethiopia to evaluate and select high yielding NERICA genotypes. A total of fourteen rice genotypes consisting of 9 NERICA, 3 FOFIFA and 2 genotypes as check, laid down in a randomized complete block design with three replications were used as treatments. The study revealed highly significant ($p<0.01$) difference between all genotypes with respect to yield and yield component traits studied in the three locations, except for panicles per plant at Shebe. NERICA4 and NERICA3 gave the highest mean grain yield at Shebe (6008.9 and 5866.7 kg ha^{-1}) and Gomma-2 (4262.2 and 3915.6 kg ha^{-1}). At Eladale, the local check (X-Jigna) was with the highest yielder (1080 kg ha^{-1}). Among NERICA genotypes tested, 77% of them recorded 5-6 tons of grain yields per hectare at Shebe. Performance of all genotypes increased sharply with decrease in altitude from Eladale to Shebe and vice versa. Mean grain yield advantage of 20-23% was achieved by NERICA4 and NERICA3 over check genotypes at Shebe. The two NERICA varieties were recommended for rice producing farmers with an altitude range of below 1500 m a. s. l. to maximize grain yields in Southwest Ethiopia.

Key words: Rain fed upland, NERICA genotype, grain yield, yield component, *Oryza sativa*

INTRODUCTION

More than half of the world's population depends on rice for its major daily source of food energy and protein and thus the importance of rice in relation to food security and socio-economic stability is self-evident (FAO, 2003). Rice is the fastest growing source of food in Africa. During the past three decades rice grain has seen a steady increase in consumption and demand given its important place in the strategic food security planning policies of many African countries (Norman and Otoo, 2003; Africa Rice Center, 2007; Forum for Agricultural Research in Africa, 2009).

Rice is proven to be one of the potential strategic commodity crops that can assure food security and poverty reduction in Ethiopia (Seyoum and Gebrekidan, 2005; Gebrekidan and Seyoum, 2006; Zenna *et al*., 2008; http://riceforafrica.org/card2/downloads/Meetings/recent/12.Ethiopia_National%20Rice%20R&D%20Emailed%20(July%205,%202010).ppt). Moreover, rice could also be considered as one of the best and cheapest alternative technology available to small-scale farmers for improving productivity of grain yields in flooded and swampy environments through efficient utilization of land and water (Seyoum, 1999, 2000; Gebrekidan and Seyoum, 2006). The recent surge in demand triggered by soaring import price, consumer preference in urban areas (Zenna *et al*., 2008), population growth and rapid urbanization forced the country to expand small-scale and commercial rice production in various agro-ecologies, leading to food self-sufficiency by 2014 (http://riceforafrica.org/card2/ downloads/Meetings/ recent/12.Ethiopia_National%20Rice%20R&D%20Emailed%20(July%205,%202010).ppt). As a result of which, rice production is escalating rapidly from year to year (Gebrekidan and Seyoum, 2006; Aredo *et al*., 2008; Zenna *et al*., 2008). The cultivated area and yield production increased from 19,000 to 156,000 hectares and from 43,000 to 500,000 tons from 2006 to 2009, respectively (http://riceforafrica.org/card2/ downloads/Meetings/ recent/12.Ethiopia_National%20Rice%20R&D%20Emailed%20(July%205,%202010).ppt).

Rice is believed to be introduced to Ethiopia in the early 1970s (Gebrekidan and Seyoum, 2006). Until recently, nearly all the rice varieties grown in the country were Asian types (MARD, 2010), usually showing poor adaptation in upland environments. Therefore, to meet the fastest growing demand for source of food and exploit untapped agricultural potentials, ''New Rice for Africa'' (NERICA) has recently been introduced and grown in different parts of the country (Zenna *et al*., 2008).

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NERICA is derived from the crossing of the African rice (*O. glaberimma* Steud.) and the Asian rice (*O. sativa* L.) and possess high yield potential, early vigor, short growth cycle, tolerance to abiotic stress such as drought, resistance to blast and rice yellow mottle virus, good response to fertilizers, good grain qualities, non-shattering grains and holds up to 400 grains per panicle compared to 75 to 100 grains of its African parents (WARDA, 2001a). Therefore, introduction of NERICA in the farming system raises significantly the productivity, income and food security of rain fed upland rice farmers in sub-Saharan Africa (Africa Rice Center, 2008a, b; Zenna *et al*., 2008; Atera *et al*., 2011).

Monty Jones (WARDA, 2001b) reported that NERICA's yield is as high as 2.5 tons per hectare under low inputs and 5 tons or more with prudent fertilizer use, with about 25 to 250% production increases. Field evaluation results in different parts of Africa showed high yield potential of NERICA than traditional upland varieties. In Ethiopia, NERICA grown in rainfed uplands, registered paddy yields of 3 to 6 tons per hectare (Zenna *et al*., 2008; MARD, 2010). The average yield of NERICA in Uganda is 2.2 tons per hectare which is much higher than the average upland rice yield of 1 ton per hectare in Sub-Saharan Africa (Kijima *et al*., 2006; Africa Rice Center, 2008a). In Guinea and Côte d'Ivoire, modest applications of fertilizer have boosted the output to 3.5 tons per hectare; in Guinea NERICA yields are 2 to 3 times higher than those of standard rice varieties (Harsch, 2004; ISIS, 2004). Grain yields of 2.2 to 4.3 tons per hectare were also recorded in Kenya (Atera *et al*., 2011; Kega and Maingu, 2011).

Given their high yield potential and agronomic merits in upland environments, dissemination and expansion of NERICA is moving up in different potential areas of the country (Zenna *et al*., 2008). Southwest Ethiopia is one of the potential areas where rice is being produced mainly in rainfed upland ecology. However, rice research and development out puts are very limited in the area to satisfy the growing demand of small-scale farmers for improved rice varieties. Therefore, the major objective of present study was to evaluate and select high yielding NERICA genotypes for upland ecology of Southwestern Ethiopia.

MATERIALS AND METHODS

Experimental sites: Field experiments were conducted in upland rainfed ecology during the main rainy seasons of 2009 and 2010 at three different locations of Southwest Ethiopia: Eladale, Gomma-2 and Sbebe. The agro-ecological characteristics of the locations are shown in Table 1.

Table 1: Description of rice experimental locations in Southwest Ethiopia

	Locations		
Characteristics	Eladale	Gomma-2	Shebe
Latitude	7°42' N	7°57' N	7°28' N
Longitude	36°48' E	36°38' E	36°25' E
Altitude (m a.s.l)	1813	1497	1370
Annual rainfall (mm)	1616	1470.4	1420
Annual maximum temperature (°C)	28.4	29.5	30
Annual minimum temperature (°C)	12.4	13.5	14
Soil type	Clay	Clay	Clay loam
Soil pH	5.53	6.15	6.37

Genotypes used, design and procedures: A total of fourteen rice genotypes composed of 9 NERICA (NERICA-1, NERICA-2, NERICA-3, NERICA-4, NERICA-7, NERICA-12, NERICA-13, NERICA-14 and NERICA-18), 3 FOFIFA (FOFIFA-3730, FOFIFA-3737 and FOFIFA-4129) and 2 widely grown genotypes as check: IAC-164 (*Gumara*) and X-Jigna (local) were used in the study. The experiment was arranged in a randomized complete block design (RCBD) with three replications at each location. A five-row plots with size of 6 m^2 (1.2×5 m) were used. Spacing between blocks and plots was 1 m and 0.5 m, respectively.

Sowing was done between May 28 and June 11 during the main cropping seasons. Early planting dates were followed at high altitude (Eladale) while late planting was carried out at low altitude (Shebe). Dry seeds were hand drilled at a rate of 60 kg ha^{-1} in rows spaced 25 cm apart. Thinning was carried out at 3-4 leaf stage to maintain single plant per hill at a spacing of 10 cm. Mineral fertilizers were applied at a rate of 64 kg N and 46 kg P_2O_5 ha^{-1} as Urea and di-ammonim phosphate (DAP) at each location. Nitrogen was applied in two equal splits: half at sowing and half at panicle initiation (booting) stage. Total dose of P_2O_5 was applied basal. Three manual weeding were carried out at 20, 40 and 60 days after sowing.

Data collection and analysis: Observation and data record for all traits studied was made based on the Standard Evaluation System for rice (IRRI, 2002). Panicles per plant, number of grains per panicle and panicle length were measured before physiological maturity from randomly selected 10 sample plants in the middle three rows of each plot. Grain yield was measured at physiological maturity by harvesting the 3 central rows (0.75×5 m = 3.75 m^2) of each plot and adjusted to grain moisture content of 14%. Thousand-grain weight was determined from bulked grain samples in each plot and recorded on 14% seed moisture content basis.

Data for yield and yield component traits were subjected to analysis of variance for RCBD as described by Gomez and Gomez (1984) using SAS version 9.1 (SAS, 2003). After having test of homogeneity of variances for each traits studied at the three locations, combined analysis of variance was done over years for each location to determine the effects of genotypes by year interaction. The difference between treatment means was compared using least significance difference at 5% probability levels. Simple correlation coefficients were carried out for the yield and yield components studied.

RESULTS AND DISCUSSION

Analysis of variance: Significant variation ($p<0.01$) did exist among all the genotypes in grain yield and yield components studied at the three locations, except for panicles per plant at Shebe (Table 2). Significant genotypic effect on grain yield and its components indicates that rice genotypes were genetically different. The effect of two years was highly significant for grain yield and yield attributes examined at Eladale and Gomma-2 but only grain yield, panicles per plant and panicle length showed significant differences at Shebe (Table 2). The genotype by year (G×Y) interaction was also significant for some of the traits studied: yield, panicle length and thousand grain weight at Eladale; panicle length and thousand grain weight at Gomma-2; and panicles per plant and panicle length at Shebe (Table 2). The interaction effect could be as a result of genotypic differences. Agbo and Obi (2005) and Atera *et al.* (2011) also reported significant genotype by year interaction in upland rice. The traits with non-significant G×Y effect might be exhibiting consistency (Kang, 1997; Agbo and Obi, 2005) in spite of the various differences that existed in the two years experiment.

Grain yield: The mean grain yield of NERICA genotypes at Eladale ranged from 462.22 to 835.56 kg ha^{-1} for NERICA1 and NERICA14, respectively (Table 3). Among all genotypes studied at Eladale (Table 3), X-Jigna gave the highest mean grain yield (1080 kg ha^{-1}), followed by FOFIFA3737 (951.1 kg ha^{-1}) and NERICA14 (835.56 kg ha^{-1}). NERICA1 gave the lowest mean grain yield (462.22 kg ha^{-1}). The mean grain yield of NERICA genotypes at Gomma-2 ranged from 2408.9 to 4262.2 kg ha^{-1} for NERICA13 and NERICA4, respectively (Table 4). NERICA4 was the highest yielder (4262.2 kg ha^{-1}), followed by NERICA3 (3915.6 kg ha^{-1}) and NERICA1 (3333.3 kg ha^{-1}). NERICA13 gave the lowest mean grain yield (2408.9 kg ha^{-1}). The mean grain yield of NERICA genotypes at Shebe ranged from 4266.7 to 6008.9 kg ha^{-1} for NERICA18 and NERICA4, respectively (Table 5). Similarly, NERICA4 recorded the highest mean grain yield (6008.9 kg ha^{-1}) at Shebe followed by NERICA3 (5866.7 kg ha^{-1}) and NERICA7 (5773.3 kg ha^{-1}). NERICA18 gave the lowest mean grain yield (4266.7 kg ha^{-1}). Genetic differences among genotypes and environmental influences at each locations accounted to varied yield level records. Similar yield levels of NERICA genotypes were reported in Ethiopia and elsewhere in African (Zenna *et al.*, 2008; Teferi, 2009; Atera *et al.*, 2011; Kega and Maingu, 2011).

Contribution of yield components to grain yield: Grain yield level in rice is determined by yield component traits. Results of the present study indicated that X-Jigna recorded the highest number of panicles per plant (7.27) and grains per panicle (29.67) at Eladale (Table 3). At Gomma-2 (Table 4), NERICA4 gave the highest number of panicles per plant (8.33) and grains per panicle (99.0). Similarly, NERICA4 gave the highest number of panicles per plant (10.85) and grains per panicle (144.33) at Shebe (Table 5). Mean values of all yield components recorded

Table 2: Analysis of variance for grain yield and yield components of rice in Southwest Ethiopia

	Mean squares				
Source of variation	Panicles per plant (No.)	Grains per panicle (No.)	Panicle length (cm)	Thousand grain weight (g)	Grain yield (kg ha^{-1})
Eladale					
Replication	1.6489^{ns}	35.5119^{ns}	0.1805^{ns}	7.0868^{ns}	25303.704^{ns}
Genotype (G)	2.6204**	97.1401**	3.1807**	19.0558**	146989.662**
Year (Y)	15.4286**	1433.4405**	30.9643**	348.5144**	376897.354**
G×Y	0.4032^{ns}	24.1071^{ns}	0.9904*	18.8429*	42656.899*
Error	0.5845	19.0799	0.4852	2.741	18025.79
Gomma-2					
Replication	1.1944^{ns}	150.6786^{ns}	2.0104*	2.1264^{ns}	82311.11^{ns}
G	2.9684**	685.5824**	2.511**	17.7604**	1571814.08**
Y	55.8601**	7657.1905**	72.4286**	47.5956**	3500097.35**
G×Y	0.5793^{ns}	140.9597^{ns}	1.2604**	9.2549**	58501.91^{ns}
Error	0.9218	91.0366	0.4341	2.8887	255014.5
Shebe					
Replication	2.3230^{ns}	121.0833^{ns}	4.7644**	2.1793^{ns}	126281.48^{ns}
G	1.8345^{ns}	807.7802**	3.0269**	15.2981**	1815644.44**
Y	42.2876**	505.1905^{ns}	23.0476**	0.575^{ns}	2262764.02**
G×Y	2.9371*	141.7033^{ns}	3.3204**	1.3162^{ns}	67326.98^{ns}
Error	1.3668	178.7623	0.797	1.6788	280364.3

*, **Significant at 5 and 1% level of probability respectively; ns: Non significant

Table 3: Mean grain yield and yield component performance of rice genotypes from 2009 to 2010 at Eladale, Southwest Ethiopia

	Mean grain yield and its components				
Genotypes	Panicles per plant (No.)	Grains per panicle (No.)	Panicle length (cm)	Thousand grain weight (g)	Grain yield (kg ha^{-1})
NERICA14	6.40^{abc}	26.17^{abc}	16.32^{cd}	24.92^{bcd}	835.56^{bc}
NERICA3	6.02^{bcd}	21.67^{cd}	16.70^{bc}	23.85^{de}	666.67^{def}
NERICA4	5.90^{cd}	23.50^{bcd}	17.48^{ab}	24.13^{cde}	768.89^{cde}
NERICA7	5.95^{cd}	23.33^{bcd}	16.72^{bc}	23.53^{def}	715.56^{cde}
NERICA12	5.48^{d}	19.50^{def}	15.78^{de}	22.47^{ef}	640.00^{ef}
NERICA13	6.28^{bcd}	23.17^{bcd}	16.72^{bc}	25.87^{abc}	764.44^{cde}
NERICA2	5.42^{de}	16.17^{ef}	17.70^{a}	21.87^{fg}	542.22^{fg}
NERICA18	6.23^{bcd}	21.17^{cde}	15.75^{de}	22.50^{ef}	733.33^{cde}
NERICA1	4.53^{e}	15.33^{f}	15.45^{e}	20.37^{g}	462.22^{g}
FOFIFA3730	6.18^{bcd}	23.83^{bcd}	15.40^{e}	26.40^{ab}	831.11^{bc}
FOFIFA3737	6.90^{ab}	28.17^{ab}	16.27^{cd}	26.83^{a}	951.11^{ab}
FOFIFA4129	5.93^{cd}	20.00^{def}	16.53^{cd}	24.10^{cde}	671.11^{def}
X-Jigna	7.27^{a}	29.67^{a}	16.28^{cd}	23.48^{def}	1080.00^{a}
IAC-164	5.60^{cd}	23.17^{bcd}	15.37^{e}	23.13^{def}	795.56^{cd}
Mean	6.01	22.49	16.32	23.82	749.98
CV (%)	12.73	19.42	4.27	6.95	17.97
$LSD_{0.05}$	0.8849	5.0561	0.8063	1.9164	155.41

Means within a column followed by the same letter (s) are not significantly different at 1% level of probability

Table 4: Mean grain yield and yield component performance of rice genotypes from 2009 to 2010 at Gomma-2, Southwest Ethiopia

	Mean grain yield and its components				
Genotypes	Panicles per plant (No.)	Grains per panicle (No.)	Panicle length (cm)	Thousand grain weight (g)	Grain yield (kg ha^{-1})
NERICA14	6.93^{bcde}	83.33^{b}	18.37^{cd}	27.36^{ab}	2915.60^{cdef}
NERICA3	7.85^{ab}	96.33^{a}	18.08^{cde}	22.14^{e}	3915.60^{ab}
NERICA4	8.33^{a}	99.00^{a}	18.50^{bc}	24.20^{cd}	4262.20^{a}
NERICA7	7.20^{bcd}	71.83^{cdef}	18.65^{bc}	24.69^{cd}	3200.00^{cd}
NERICA12	6.83^{bcde}	78.50^{bc}	18.35^{cd}	25.14^{cd}	3031.10^{cde}
NERICA13	5.83^{e}	65.50^{def}	19.45^{a}	28.17^{a}	2408.90^{f}
NERICA2	6.33^{de}	62.33^{f}	19.18^{ab}	25.72^{bc}	2466.70^{ef}
NERICA18	7.50^{abc}	75.00^{bcde}	17.70^{def}	23.40^{de}	3235.60^{c}
NERICA1	7.87^{ab}	79.83^{bc}	17.65^{def}	24.66^{cd}	3333.30^{bc}
FOFIFA3730	6.35^{de}	64.00^{ef}	17.22^{f}	27.43^{ab}	2751.10^{cdef}
FOFIFA3737	7.22^{bcd}	76.17^{bcd}	17.35^{ef}	25.60^{bc}	3004.40^{cde}
FOFIFA4129	6.67^{cde}	77.67^{bc}	18.37^{cd}	23.45^{de}	3222.20^{cd}
X-Jigna	6.83^{bcde}	77.83^{bc}	17.67^{def}	23.93^{cde}	2897.80^{cdef}
IAC-164	6.33^{de}	71.67^{cdef}	18.17^{cd}	24.05^{cde}	2648.90^{def}
Mean	7.01	77.07	18.19	25.00	3092.38
CV (%)	13.70	12.38	3.62	6.80	16.33
$LSD_{0.05}$	1.1113	11.044	0.7626	1.9673	584.53

Means within a column followed by the same letter (s) are not significantly different at 1% level of probability

Table 5: Mean grain yield and yield component performance of rice genotypes from 2009 to 2010 at Shebe, Southwest Ethiopia

	Mean grain yield and its components				
Genotypes	Panicles per plant (No.)	Grains per panicle (No.)	Panicle length (cm)	Thousand grain weight (g)	Grain yield (kg ha^{-1})
NERICA14	10.17^{ab}	108.00^{def}	20.80^{def}	29.27^{bc}	4382.20^{f}
NERICA3	10.70^{a}	130.67^{abc}	21.42^{bcde}	27.17^{d}	5866.70^{a}
NERICA4	10.85^{a}	144.33^{a}	21.90^{abc}	27.12^{d}	6008.90^{a}
NERICA7	10.83^{a}	135.17^{ab}	21.72^{bcd}	27.03^{d}	5773.30^{ab}
NERICA12	10.68^{a}	128.50^{bc}	22.02^{ab}	29.47^{bc}	5595.60^{abc}
NERICA13	10.80^{a}	131.83^{abc}	22.78^{a}	29.51^{abc}	5155.60^{cde}
NERICA2	10.20^{ab}	125.83^{bc}	21.92^{abc}	28.26^{cd}	5102.20^{cde}
NERICA18	11.13^{a}	106.50^{ef}	21.63^{bcd}	27.57^{d}	4266.70^{f}
NERICA1	9.00^{b}	121.33^{bcde}	20.95^{def}	27.13^{d}	5093.30^{cde}
FOFIFA3730	10.25^{ab}	102.83^{f}	19.98^{f}	31.00^{a}	5222.20^{bcd}
FOFIFA3737	10.38^{a}	129.67^{abc}	20.58^{ef}	29.73^{abc}	5604.40^{abc}
FOFIFA4129	10.35^{ab}	123.17^{bcd}	21.90^{abc}	30.16^{ab}	5226.70^{bcd}
X-Jigna	11.27^{a}	120.67^{bcde}	21.30^{bcde}	25.07^{e}	4684.40^{def}
IAC-164	10.72^{a}	118.83^{cde}	21.83^{abcd}	28.35^{cd}	4600.00^{ef}
Mean	10.52	123.38	21.48	28.35	5184.44
CV (%)	11.11	10.84	4.16	4.57	10.21
$LSD_{0.05}$	1.3533	15.476	1.0334	1.4998	612.90

Means within a column followed by the same letter (s) are not significantly different at 1% level of probability

Table 6: Simple correlation coefficients (*r*) among grain yield and yield components of rice genotypes

Grain yield and yield components	Panicle length (cm)	Panicles per plant (No.)	Grains per panicle (No.)	Thousand grain weight (g)	Grain yield (kg ha^{-1})
Panicle length	-	-0.009	0.396	-0.113	0.153
Panicles per plant		-	0.632*	-0.139	0.487
Grains per panicle			-	-0.215	0.847**
Thousand grain weight				-	-0.199
Grain yield					-

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

at Shebe was higher than Gomma-2 and Elada. Depending on the type of genotype, change in the number and size of yield components affected yield levels. Grain yield has been reported to be influenced by panicles per plant, grains per panicle and grain weight (Jiang *et al*., 2007; Xing and Zhang, 2010; Akinwale *et al*., 2011).

In this study, however, grains per panicle contributed a lot to grain yield than other yield component traits. Association of grains per panicle with grain yield (Table 6) was positive and significant (r = 0.847**) which suggested that improvement in grains per panicle would lead to increase in rice grain yield. In agreement with the reports of Gravois and Helms (1992) and Hairmansis *et al*. (2010), the present investigation revealed the importance of grains per panicle in determining grain yield levels. Mustafa and Elsheikh (2007) and Sadeghi (2011) noted that grains per panicle is one of yield components frequently make the greatest contribution to rice grain yield. Grains per panicle was also showed positive and significant correlation (r = 0.632*) with number of panicles per plant (Table 6). Increase in the number of panicles per plant results in high level of yield in rice. Similar results were reported by Gebrekidan and Seyoum (2006).

Influence of altitude on yield and yield components: The magnitude of change in mean grain yield and yield component traits increased as altitude decreased, the highest record being at Shebe, followed by Gomma-2 and Eladale (Table 3-5). As a result, mean grain yields of all genotypes recorded at Shebe (5184.4 kg ha^{-1}) out yielded Goma-2 by 40.5% (2092 kg ha^{-1}) and Eladale by 85.5% (4434.46 kg ha^{-1}). The present study revealed that apart from genetic differences, environmental factors influenced the growth and yield performance of rice genotypes.

Among environmental variables of the experimental locations (Table 1), low temperature prevailed at high altitude might have influenced genotypes to great extent by affecting the reproductive and grain filling stages. As a result, grains per panicle at Eladale (22.49) were dropped by 81.8% from Shebe (123.38). Rice is a cold sensitive plant (Yoshida *et al*., 1996) and the prevalence of cool air temperatures below 15°C at flowering growth stage increases sterility (Nishiyana, 1995; Zenna and Berhe, 2009) thereby reduce the number of grains per panicle (Gebrekidan and Seyoum, 2006). Compared to other genotypes tested, most of NERICA varieties were negatively affected by high altitude at Eladale. Similar observation was reported by Teferi (2009) on NERICA genotypes evaluated in Northwest parts of Ethiopia where high level of grain yield was recorded at Metema (745 m a.s.l) than Woreta area (1812 m a.s.l). Tareke (2003) also noted that altitude would be a critical factor in Ethiopia for the adaptation of NERICA genotypes.

CONCLUSIONS

The result confirmed that the highest grain yield record was obtained from NERICA genotypes. It is quite encouraging for rice growing farmers in the lowland areas that 77% of NERICA genotypes tested recorded 5 to 6 tons of grain yields per hectare. NERICA4 and NERICA3 were the first and second top yielding genotypes, respectively in which both genotypes recorded grain yield advantage of 20-23% at Shebe over check genotypes. Besides genetic differences, it was also noted that environmental factors, such as altitude and temperature affected the yield potential of all rice genotypes tested. Growing of NERICA rice genotypes in their suitable ecology is therefore necessary for exploiting their maximum genetic potential. In conclusion, NERICA4 and NERICA3 varieties were recommended for rice producing farmers with an altitude range of below 1500 m a. s. l. to maximize rice grain yields in Southwest Ethiopia and other similar areas.

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