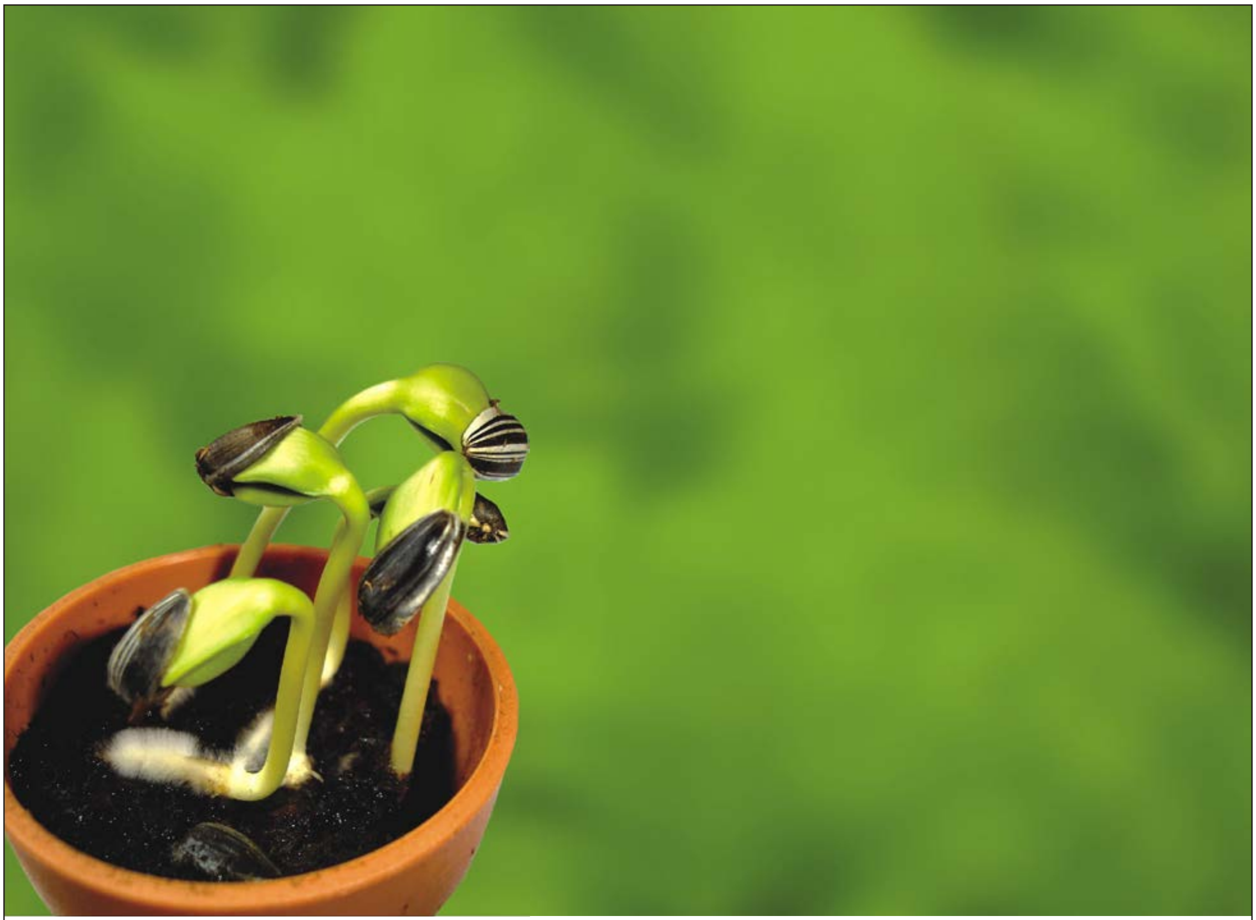

International Journal of

Plant Breeding and Genetics

ISSN 1819-3595

Academic
Journals Inc.

www.academicjournals.com

International Journal of Plant Breeding and Genetics 5 (3): 224-234, 2011
ISSN 1819-3595 / DOI: 10.3923/ijpbg.2011.224.234

Comparative Performance of Lowland Hybrids and Inbred Rice Varieties in Nigeria

[1]M.G. Akinwale, [2]G. Gregorio, [1]F. Nwilene, [4]B.O. Akinyele, [3]S.A. Ogunbayo, [4]A.C. Odiyi and [5]A. Shittu
[1]Africa Rice Center (AfricaRice), PMB 5320, Ibadan, Oyo State, Nigeria
[2]International Rice Research Institute (IRRI), DAPO Box 7777, Metro Manila, Philippines
[3]Africa Rice Center (AfricaRice), 01 BP 2031, Cotonou, Benin Republic
[4]The Federal University of Technology, Akure, Nigeria
[5]International Institute of Tropical Agriculture (IITA), PMB 5320, Ibadan, Oyo State, Nigeria

Corresponding Author: B.O. Akinyele, Department of Crop, Soil and Pest Management, The Federal University of Technology, P.M.B 704, Akure, Nigeria

ABSTRACTS

The objective of this study was to compare the grain yield performance of lowland hybrids with that of some inbred varieties of rice in Nigeria with a view to identifying which of the two groups exhibits higher grain yield. Yield potential of 14 rice varieties comprising 10 commercial hybrids, 2 inbred varieties and 2 lowland NERICAs were evaluated at the Africa Rice Center, Ibadan Station during 2008 wet and 2009 dry seasons. The experiment was laid out in a randomized complete block design with three replications. Agronomic data were collected on days to 50% flowering, days to maturity, plant height, number of panicles per m^2, panicle length, number of tillers per plant, panicle weight, number of grains per panicle, 1000 grain weight and grain yield. The number of panicles per m^2, panicle weight and number of grains per panicle were significantly higher in the hybrids than in the inbred and interspecific varieties. The hybrids had the highest grain yield compared to the inbred and the interspecific lowland NERICA varieties. The results indicated that hybrids exhibited significant yield increase of 13.44% over the best lowland NERICAs and 15.17% over the best inbred variety WITA 4. The number of panicles per m^2, panicle weight and number of grains per panicle appeared to be the main traits that contribute to higher grain yield in the hybrids. Therefore, the hybrids with the highest grain yield have huge potential in raising rice productivity in Nigeria.

Key words: Yield potential, *Oryza sativa*, interspecific lowland NERICA, performance, grain

INTRODUCTION

Rice (*Oryza sativa* L.) is a staple food for half of the world population and approximately three quarter of a billion of the world's poorest people depend on the staple to survive. In Sub-Sahara Africa, over 20 million farmers grow rice and about 100 million people depend on it for their livelihoods (WARDA, 2005). The demand for rice in Sub-Sahara Africa is expected to grow substantially as the population is currently growing at the rate of 3-4% per annum and rice consumption is growing faster than that of any major food. To attain rice self-sufficiency and meet the future demand resulting from population growth, productivity in rice production has to be increased. Currently, it is believed that high yielding inbred varieties developed through conventional breeding have reached a yield plateau. Irrigated rice is shrinking as irrigation water is being diverted for other uses. Agricultural labor is moving to industry and concern is rising about pesticides. Drought, according to Kim and Kim (2009), is also a serious threat to sustainability of rice yields in rain fed agriculture. Therefore, the use of improved rice varieties and the right management practices should be encouraged to stabilize rice yield, when water is in short supply, labour is inadequate and the land available for cultivation is limited. To break the yield barrier, several approaches have been explored. These include development of a modified new plant type with low tillering capacity and large panicles from tropical *japonica* germplasm, incorporation of genetic factors capable of increasing grain yield under drought stress and exploitation of heterosis through inter-varietal and inter-subspecific hybrids. Efforts aimed at breaking the yield barrier in rice and wheat have been amply demonstrated by Luo (2010), Kim and Kim (2009), Haake *et al.* (2002), Lanceras *et al.* (2004), Degenkolbe *et al.* (2009), Akhter *et al.* (2003), Nuruzzaman *et al.* (2002), Chen *et al.* (2009) and Tiwari *et al.* (2011). The possibility of significantly increasing rice yield through genetic improvement in Africa has been demonstrated by Africa rice. This effort has recorded considerable progress and success through the synthesis of NERICA, a high yield, stress resistant rice developed through crossing of *Oryza glaberima* and *O. sativa* (Jones *et al.*, 1997; Jones, 1998). The new rice displayed heterosis, the phenomenon in which the progeny of two genetically different parents grow faster, yield more and resist stresses better than either parents. NERICA contributed up to six percent increase in the continent's rice output in 2007. Globally, commercial hybrid is being considered as another genetic improvement towards increasing rice yield. Hybrid refers to the first filial generation of cross between two genetically diverse parents. Commercial hybrid refers to a superior F_1 which not only outperforms the better parent but also show significant yield superiority over the best high yielding inbred variety of similar duration (Virmani and Kumar, 2004). A hybrid is commercially valuable only when it exhibits significantly high standard heterosis over the best locally adopted varieties. Hence, the success of hybrid rice program is dependent on the magnitude of heterosis. A good hybrid, therefore, should manifest high heterosis for commercial exploitation. It has been proved practically for many years in China that hybrid rice has more than 20% yield advantage over improved inbred varieties (Tiwari *et al.*, 2011). The two forms of hybrids (NERICA and Commercial) exhibited the phenomenon of heterosis for superior agronomic performance. This study attempts to evaluate the agronomic performance of 10 hybrids, 2 lowland NERICAs and 2 inbred varieties.

MATERIALS AND METHODS

The study was conducted at the experimental station of Africa rice in the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria in 2008 and 2009 dry and wet seasons respectively. Africa rice, Ibadan station is located at 7° 26'N latitude, 3° 54'E longitude and at an elevation of about 234 m above mean sea level. The soil type is altisol. A total of 14 varieties which consist of 10 commercial hybrids, bred from International Rice Research Institute (IRRI), Philippines, 2 interspecific lowland NERICAs from AfricaRice Center, Cote d'Ivoire, 1 inbred variety from IRRI and 1 released lowland varieties in Nigeria were evaluated for yield performance. Seeds were sown in the nursery and transplanted at 21-day-old into puddled field. One seedling was transplanted per hill at a spacing of 20 cm between and within hills. The randomized complete block design with three replications was used. There were 10 rows of 5 m and the plot area was 10 m^2. Inorganic fertilizer was applied at 200 kg ha^{-1} before transplanting using NPK (15-15-15) and top dressed with Urea at the rate of 65 kg N ha^{-1} at the tillering stage and 35 kg N ha^{-1} at the booting stage. Approximately 5 cm of standing water was maintained in the field until drainage before harvest. Weeds were controlled by application of post-emergence herbicide (orzo plus at 3 L ha^{-1}) 14 Days After Transplanting (DAT) and hand weeding was carried out as and when due.

Data collection and statistical analysis: Morphological data were collected for ten quantitative characters at the appropriate growth stage of rice plant following the descriptor for rice *Oryza sativa* L. (IRRI, 2002). The characters that were evaluated are days to 50% flowering, days to maturity, plant height, number of tillers per plant, number of panicles per m^2, panicle length, 1000 grain weight, panicle weight, number of grains per panicle and grain yield. All the linear measurements were done using a tape graduated in centimeters while weights were taken using a weighing balance. The data collected on 10 agro-botanical traits from the rice accessions were subjected to statistical analysis using SAS/PC version 9.2. Phenotypic correlation was calculated using Pearson's linear correlation as outlined by Steele and Torrie (1984).

RESULTS

The combined analysis of variance revealed that genotypic differences were highly significant for all the traits observed (Table 1). Season differed significantly for days to 50% flowering, days to maturity, plant height, number of tillers per plant and grain yield.

Days to 50% flowering: The data obtained across seasons showed that there are significant differences for days to 50% flowering and days to maturity among hybrids, inbred and interspecifics. Duration to 50% flowering was significantly different between varieties at ($p<0.001$) with inbred variety IR77674 taking the shortest time of 86 days to attained 50% flowering while hybrids IR 82378H, IR83202H and inbred variety WITA 4 took 92, 91 and 94 days, respectively (Table 2). Among the hybrids, duration to 50% flowering was shortest in IR 82363H taking 88 days and longest in IR 82378H taking 92 days. NERICA L-34 reached the 50% flowering stage earlier than the earliest hybrid. This type of variability might be attributed to the parental combination of individual varieties and the genotype-environment interaction.

Days to maturity: In the combined analysis, significant genetic variation was observed among the hybrid, interspecific lowland NERICAs and inbred in the time taken to maturity (Table 2). The duration to maturity ranged between 116 to 124 days with inbred IR77674 taking the shortest time (116 days) and WITA 4 taking the longest time (124 days). Among the hybrids, IR82363H was the earliest maturing variety taking 118 days while the longest maturing hybrid is IR82378H taking 122 days to maturity. Among the interspecific, NERICA-L-34 was the earliest maturing variety taking the same number of days (118) with the earliest maturing hybrid. Days to 50% flowering varied from 2008 Wet Season (WS) to 2009 Dry Season (DS). It ranged from 88 days for IR77674 to 96 for WITA4 in 2008 (Table 3) and from 83 days for IR77674 to 92 days for WITA4 in 2009 (Table 4). Days to maturity ranged from 118 days for IR77674 to 126 days for WITA4 in 2008 and 114 days for IR77674 to 122 days for WITA4 in 2009. All the varieties evaluated matured earlier in 2009 dry season except NERICA- L-34 that took the same number of days as in 2008.

Plant height: Plant height varied significantly among varieties for both within and across seasons. Across seasons, WITA 4 recorded maximum plant height of 123.39 cm which was significantly higher than that of the hybrids and the interspecifics while the lowest plant height of 93.65 cm was recorded for NERICA L-34 (Table 2). Among the hybrids, the highest height of

Table 1: Mean squares from analysis of variance for ten traits in fourteen rice accessions

Source of variation	df	Days to flowering	Days to maturity	Plant height (cm)	No. of tiller/plant	No. of panicle/m^2	Panicle length	Panicle weight	No. of grain/panicle	1000 grain weight	Grain yield (t ha^{-1})
Season	1	810.96***	732.19***	2414.30***	88.33***	4573.90^{ns}	0.27^{ns}	0.05^{ns}	5.14^{ns}	7.2^{ns}	50.90***
Rep (season)	3	4.6^{ns}	0.36^{ns}	20.57*	0.99^{ns}	487.11^{ns}	6.70^{ns}	0.77^{ns}	89.68^{ns}	3.80^{ns}	0.15^{ns}
Variety	13	25.36***	23.17***	392.60***	30.36***	10782.06***	15.71***	3.68***	3977.28***	15.90**	2.61***
Season×Variety	13	13.04***	14.62***	123.084***	10.54***	3260.55*	2.42***	0.07^{ns}	384.92^{ns}	3.69ns	0.80***
Error		1.17	0.86	2.23	1.85	38.35	3.73	0.64	17.1	2.39	0.47
Means		90.03	120.26	102.75	16.96	378.43	25.77	4.53	162.34	31.26	4.89
CV		1.3	0.71	2.17	10.96	10.13	13.86	14.12	10.55	7.65	9.71
R^2		0.94	0.96	0.97	0.76	0.7	0.59	0.69	0.78	0.56	0.88

: Significant at p<0.05; *: Significant at p<0.001 (1%) level, ns: Non significant

Table 2: Mean performance of fourteen tested varieties for 2008 and 2009 cropping seasons

Variety	Days to flowering	Days to maturity	Plant height(cm)	No. of tiller/plant	No. of panicle/m2	Panicle length	Panicle weight	No. of grain/panicle	1000 grain weight	Grain yield at (t ha^{-1})
IR 77674	86.16^{h}	116.33^{g}	108.20^{c}	15.00^{ef}	292.00^{g}	28.97^{a}	3.26^{efgh}	149.50^{efgh}	31.98^{ba}	3.76^{d}
IR75217H	90.16^{de}	120.16^{cd}	95.38^{fg}	15.75^{de}	356.66^{cde}	25.69^{abcd}	3.87^{e}	175.38^{cd}	29.75^{bc}	4.34^{d}
IR80228H	90.66^{cd}	120.50^{cd}	98.01^{ef}	17.37^{cd}	404.25^{ab}	23.67^{cd}	5.88^{a}	180.00^{cd}	28.56^{c}	4.97^{c}
IR80637H	90.00^{de}	119.66^{de}	111.52^{b}	18.41^{bc}	420.66^{ab}	26.24^{abcd}	5.89^{a}	210.44^{a}	29.46^{bc}	5.53^{abc}
IR82363H	88.33^{fg}	118.83^{ef}	97.57^{ef}	20.32^{ab}	442.54^{a}	26.00^{abcd}	4.43^{cde}	154.22^{efg}	30.00^{abc}	4.33^{d}
IR82367H	89.50^{def}	119.83^{cd}	104.45^{d}	13.31^{f}	325.08^{ef}	24.3^{cd}	3.44^{gh}	144.22^{fgh}	32.63^{a}	3.99^{d}
IR82378H	92.50^{b}	122.66^{b}	106.67^{cd}	15.95^{de}	356.58^{cde}	24.68^{bcd}	4.26^{cdef}	142.11^{gh}	31.50ba	4.28^{d}
IR82386H	90.50^{cd}	120.66^{c}	98.09^{e}	14.95^{ef}	442.04^{a}	24.57^{bcd}	4.09^{defg}	133.33^{h}	32.66_{ba}	5.09^{bc}
IR82391H	90.00^{de}	120.16^{cd}	97.13^{ef}	15.79^{de}	387.50^{bcd}	26.87^{abcd}	4.75^{bc}	203.00^{ab}	33.66a	5.65^{ab}
IR83202H	91.83^{bc}	122.00^{b}	107.54^{c}	21.12^{a}	391.17^{bc}	25.48_{abcd}	5.16^{b}	164.94^{cd}	30.93^{abc}	5.81^{a}
IR85466H	90.16^{de}	120.33^{cd}	98.64^{e}	18.16^{c}	410.14^{ab}	26.78^{abcd}	4.22^{cdef}	162.33^{def}	32.86^{ab}	5.20^{abc}
NERICA-L-19	89.00^{ef}	120.00^{cd}	98.24^{e}	17.72^{cd}	349.41^{ed}	28.7^{ab}	3.67^{fgh}	141.68^{gh}	31.33^{abc}	5.22^{abc}
NERICA-L-34	87.33^{gh}	118.00^{f}	93.65^{g}	17.85^{cd}	392.83^{bc}	23.15^{d}	4.53^{bcd}	136.44^{gh}	32.34^{ab}	5.05^{bc}
WITA 4	94.33^{a}	124.50^{a}	123.39^{a}	15.75^{de}	349.16^{de}	27.33^{abc}	4.5^{cde}	186.16^{bc}	31.00^{ab}	5.12^{bc}
Means	90.03	120.26	102.75	16.96	380.01	25.84	4.43	162.99	31.35	4.9
CV	1.29	0.72	2.22	10.9	9.1	14.29	12.62	9.75	7.92	9.94
R2	0.94	0.96	0.97	0.74	0.75	0.56	0.76	0.79	0.45	0.87

Means not followed by the same letter in the same column are significantly different from each other at 5% probability level

111.52 cm was recorded for IR80637H while the lowest, 95.38 cm was recorded for IR 75217H. Shorter plant height is an important character of the hybrid to withstand lodging. In 2008 WS, plant height was generally high for all varieties (Table 3) and generally low for all varieties in 2009 DS (Table 4). This could be attributed to high evapo-transpiration that resulted to mild drought.

Number of tillers per plant: Significant varietal differences were observed for number of tillers per plant in both hybrids and interspecific lowland NERICAs (Table 2). The combined analysis revealed that hybrid IR83202H produced the highest number of tillers (21) per plant closely followed by IR 82363H that produced 20 tillers. The lowest number of tillers (13) was recorded for hybrid IR 82367H which was significantly lower than 15 and 17 recorded for inbred WITA 4 and interspecific NERICA-L-34, respectively (Table 2).

Number of panicles per m^2: The number of panicles per m^2 is generally associated with productivity in rice. The number of panicles per m^2 was significantly affected by varieties which varied from 292 for inbred IR7764 to 442 for hybrid IR82363H (Table 2). It was generally high for both hybrids and interspecifics and also for one of the inbred varieties - WITA 4. The number of panicles per m^2 took the same trend for most of the varieties in 2008 and 2009.

Panicle length: Data regarding panicle length showed significant levels of variability among the tested varieties. The longest panicle (28.97 cm) was produced by inbred IR77674 while the shortest (23.15 cm) was produced by interspecific lowland NERICA-L-34 (Table 2). The panicle length (28.97 cm) in inbred IR 77674 is statistically longer than the longest in hybrid IR82391H (26.87 cm) and in interspecific lowland NERICA-L-19 (28.70 cm).

Panicle weight: The heaviest panicle weights of 5.88 and 5.89 g were, respectively produced by hybrids IR80228H and IR 80637H. These weights were significantly higher than the heaviest panicle of 4.5 and 4.53 g produced by interspecific NERICA-L-34 and inbred WITA 4, respectively. Generally, hybrid varieties produced heavier panicles except hybrid IR75217H that produced panicle weight that is less than the least produced by the inbred variety (Table 2).

Number of grains per panicle: Number of grains per panicle is one of the most important components of yield and probably this character will be helpful in breaking the yield plateau. Number of grains per panicle differs significantly among the hybrids, the interspecifics and the inbred. The highest grain number of 210.44 was recorded for hybrid IR80637H followed by hybrid IR82391H (203) which was significantly higher than the highest in the interspecific NERICA-L-19 and in the inbred WITA4 which recorded 141.68 and 186.16, respectively (Table 2).

1000 grain weight: The highest 1000-grain weight of 33.66g was exhibited by hybrid IR82391H followed closely by IR82367H and IR82386H which recorded 32.63 and 32.63 g, respectively. Inbred WITA4 and interspecific NERICA-L-34 recorded medium 1000grain weight of 31 and 32.34 g, respectively which were statistically the same with the weight of some hybrids (Table 2). However, it was clearly seen that the 1000-grain weight of hybrids is heavier when compared to that of interspecific NERICAs and inbred.

Grain yield (t ha^{-1}): The grain yield performance of the evaluated varieties is shown in Fig. 1. Grain yield was significantly higher in the hybrid than the inbred and interspecific ($p<0.001$). Hybrids, IR83202H and IR82391H gave the highest grain yield of 5.8 and 5.65 t ha^{-1},

Table 3: Mean performance for 2008 (during wet season)

Variety	Days to flowering	Days to maturity	Plant height (cm)	No of tiller/ plant	No of panicle m^{-2}	Panicle length	Panicle weight	No of grain/ panicle	1000 grain weight	Grain yield at 14% (t/ha)
IR 77674	88.66^{d}	118.66^{ef}	117.66^{bc}	14.66^{d}	284.83^{f}	28.70^{a}	4.05^{d}	146.55^{cd}	30.33^{bc}	1.68^{f}
IR75217H	94.66^{abc}	124.66^{bc}	96.10^{f}	15.58^{cd}	335.00^{cdef}	24.91^{bcde}	3.66^{d}	167.77^{bcd}	30.20^{bc}	3.26^{e}
IR80228H	94.66^{abc}	124.66^{bc}	99.90^{e}	19.66^{abc}	402.33^{ab}	28.70^{a}	5.49^{b}	180.33^{b}	27.16^{c}	4.13^{cd}
IR80637H	94.00^{bc}	124.00^{cd}	118.16^{bc}	17.78^{bcd}	408.00^{ab}	24.91^{bcde}	6.55^{a}	211.05^{a}	29.85^{bc}	4.54^{bc}
IR82363H	92.66^{c}	122.66^{d}	102.23^{de}	23.40^{a}	391.33^{abc}	25.43^{bcde}	4.53^{bcd}	159.47^{bcde}	31.20^{ab}	3.18^{e}
IR82367H	93.33^{bc}	123.33^{cd}	116.66^{c}	14.58^{d}	318.20^{ef}	23.86^{e}	3.58^{d}	147.04^{cdef}	33.96^{a}	3.32^{e}
IR82378H	95.00^{ab}	125.00^{bc}	116.46^{c}	18.33^{bcd}	333.16^{def}	24.21^{de}	4.36^{cd}	142.00^{def}	31.66^{ab}	3.49^{de}
IR82386H	93.33^{bc}	123.33^{cd}	105.23^{d}	16.91^{bcd}	422.83^{a}	24.50^{cde}	4.17^{d}	144.18^{cdef}	32.66^{ab}	4.54^{bc}
IR82391H	93.33^{bc}	123.33^{cd}	102.16^{de}	18.33^{bcd}	422.51^{a}	26.88^{abc}	5.33^{bc}	206.44^{a}	31.66^{ab}	5.43^{a}
IR83202H	96.33^{a}	126.33^{ab}	120.33^{b}	21.07^{ab}	407.68^{ab}	26.72^{abcd}	5.00^{bc}	170.99^{bc}	30.86^{ab}	5.05^{ab}
IR85466H	94.66^{a}	124.66^{bc}	102.46^{de}	19.78^{abc}	359.16^{bcde}	26.53^{abcd}	4.11^{d}	165.33^{bcd}	31.86^{ab}	4.37^{bc}
NRICA-L-19	89.00^{abc}	119.66^{e}	96.50^{f}	18.12^{bcd}	366.48^{abcde}	25.21^{bcde}	3.60^{d}	124.07^{f}	30.33^{b}c	4.74^{abc}
NeRICA-L-34	87.66^{d}	118.00^{f}	93.65^{f}	18.00^{bcd}	384.83^{abcd}	27.50^{ab}	4.34^{cd}	132.06^{ef}	30.48^{b}c	4.67^{abc}
WITA 4	96.66^{a}	126.66^{a}	126.03^{a}	15.62^{cd}	358.33^{bcde}	26.22^{abcde}	4.21^{bcd}	174.85^{b}	31.66^{ab}	4.53^{bc}
Means	93.14	123.21	108.11	17.99	371.05	25.72	4.54	162.32	30.98	4.12
CV%	1.21	0.76	1.84	11.94	8.23	5.31	12.45	8.34	5.86	10.86
R^2	0.9	0.92	0.97	0.68	0.75	0.66	0.78	0.85	0.54	0.86

Means not followed by the same letter in the same column are significantly different from each other at 5% probability level

Table 4: Mean performance for 2009 (during dry season)

Variety	Days to flowering	Days to maturity	Plant height (cm)	No. of tiller/ plant	No. of panicle m^2	Panicle length	Panicle weight	No. of grain/ panicle	1000 grain weight	Grain yield at 14%(t/ha)
IR 77674	83.66f	114.00^{g}	98.75^{cd}	15.33^{ef}	299.16^{g}	29.25^{a}	2.47^{d}	152.44^{defg}	30.20^{a}	5.14^{cd}
IR75217H	85.66^{def}	115.66^{ef}	94.66^{defg}	15.91^{ed}	378.33^{cdef}	26.47^{a}	4.08^{bc}	182.99^{b}	29.96^{a}	5.43b^{cd}
IR80228H	86.66^{d}	116.33^{de}	96.12^{cdef}	15.75^{ed}	406.16b^{cd}	23.77^{a}	5.94^{a}	179.00^{bc}	30.62^{a}	5.81^{abc}
IR80637H	86.00^{de}	115.33^{ef}	104.87^{b}	19.33^{ab}	433.33^{abc}	26.18^{a}	5.56^{a}	209.44^{a}	29.63^{a}	6.52^{a}
IR82363H	84.00^{ef}	115.00^{fg}	92.91^{efg}	17.58b^{cd}	493.75^{a}	25.96^{a}	4.66^{b}	162.55^{cde}	30.86^{a}	5.48^{bc}
IR82367H	85.66^{def}	116.33^{de}	92.24^{fg}	12.37^{g}	331.95^{fg}	24.20^{a}	3.54^{c}	144.66^{efgh}	33.63^{a}	4.66^{d}
IR82378H	90.00^{ab}	120.33^{b}	96.87^{cde}	13.25^{g}	380.00^{cdef}	24.57^{a}	4.29^{b}	142.33^{fgh}	32.00a	5.07^{cd}
IR82386H	87.66^{cd}	118.00^{c}	90.95^{g}	13.00^{g}	461.25^{ab}	24.46^{a}	4.34^{b}	125.66^{h}	32.00a	5.65^{bc}
IR82391H	86.66^{d}	117.00^{cd}	92.09^{fg}	13.58^{fg}	352.50^{defg}	27.42^{a}	4.50^{b}	203.44^{a}	32.66a	5.87^{abc}
IR83202H	87.33^{cd}	117.66^{c}	94.75^{dfg}	20.66^{a}	374.66^{cdef}	25.37^{a}	5.33^{a}	168.22b^{cd}	31.66^{a}	6.57^{a}
IR85466H	85.66^{def}	116.^{def}	94.82^{defg}	16.83^{cde}	461.12^{ab}	25.77^{a}	4.27^{b}	162.00^{cdef}	31.86^{a}	6.04^{ab}
NERICA-L-34	87.00^{bc}	118.00^{b}	93.65^{c}	18.37^{cd}	400.83^{fg}	28.73^{a}	4.40^{c}	141.33^{cdefg}	34.20^{a}	5.44^{bc}
NERICA-L-19	89.00^{cd}	120.33^{c}	99.99^{efg}	17.33^{bc}	332.33b^{cde}	21.90^{a}	3.60^{b}	159.59^{gh}	33.00^{a}	5.51b^{cd}
WITA 4	92.00^{a}	122.33^{a}	120.75^{a}	15.87^{ed}	340.00^{efg}	27.55^{a}	4.48^{b}	178.11^{bc}	32.00^{a}	5.72^{bc}
Means	86.92	117.30	97.39	16.10	388.95	25.83	4.39	165.12	31.73	5.63
CV%	1.39	0.67	2.53	6.94	9.71	19.15	7.83	6.46	8.50	7.57
R^2	0.83	0.93	0.94	0.88	0.77	0.45	0.90	0.88	0.46	0.73

Means not followed by the same letter in the same column are significantly different from each other at 5% probability level

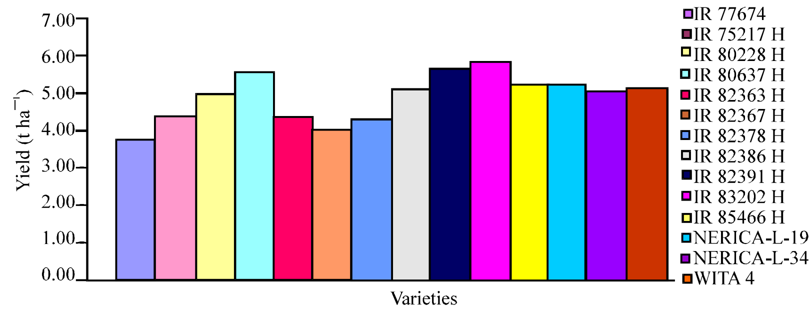

Fig. 1: Grain yield performance of evaluated varieties

Table 5: Correlation coefficients of ten traits used in characterizing fourteen rice accessions

Traits	Days to flowering	Days to maturity	Plant height (cm)	No. of panicle m^{-2}	Panicle length	No. of tiller/plant	Panicle weight	No. of grain/panicle	1000 grain weight	Grain yield at 14% t ha^{-1}
Days to flowering	1									
Days to maturity	0.98***	1								
Plant height (cm)	0.65**	0.67**								
Panicle m^{-2}	0.29^{ns}	0.24^{ns}	0.05^{ns}	1						
Panicle length (cm)	0.07^{ns}	0.34^{ns}	0.30^{ns}	0.14^{ns}	1					
No. of tiller/plant	0.32^{ns}	0.02^{ns}	0.06^{ns}	0.54*	0.15^{ns}	1				
Panicle weight (g)	0.55*	0.39^{ns}	0.25^{ns}	0.54*	0.01^{ns}	0.31^{ns}	1			
Grain/panicle	0.37^{ns}	0.3^{ns}	0.36^{ns}	0.43^{ns}	0.15^{ns}	0.10^{ns}	0.53*	1		
1000-Gwt	0.35^{ns}	0.39^{ns}	0.31^{ns}	0.43^{ns}	0.51*	0.10^{ns}	0.25^{ns}	0.34^{ns}	1	
Yld (t ha^{-1})	-0.51	-0.6	0.27^{ns}	0.59*	0.05^{ns}	0.38^{ns}	0.60*	0.52*	0.43^{ns}	1

*Significant at $p<0.05$, **Significant at $p<0.01$, ***Significant at $p<0.001$, ns: Non significant

respectively. These values are statistically higher than the highest in the interspecific NERICA-L-19 and in the inbred WITA4, which yielded 5.22 and 5.12 t ha^{-1} , respectively. Hybrid IR83202H significantly out yielded all the tested varieties. Among the hybrids, grain yield ranges from 3.9 to 5.8 t ha^{-1}, which suggested that the heterotic potential of hybrids depends on their parental lines. The two interspecific NERICAs (NERICA-L-19 (5.22 t ha^{-1}) and NERICA-L-34 (5.05 t ha^{-1}) significantly out yielded five of the hybrid varieties-IR75217H (4.35 t ha^{-1}), IR82363H (4.43 t ha^{-1}), IR82367H, (3.99 t ha^{-1}), IR82378H (4.28 t ha^{-1}) and IR 80228H (4.97 t ha^{-1}). Yield increase in the hybrids seems to be influenced by the number of grains per panicle and 1000-grain weight. The combined analysis of variance indicated that season effects were significant for grain yield (Table 1) as grain yield were low in year 2008 (Table 3) compared to year 2009 (Table 4). In year 2008, overall grain yield of the varieties ranged from 1.68 t ha^{-1} for IR77674 to 5.43 t ha^{-1} for IR82391H (Table 3) while it ranged from 4.66 t ha^{-1} for hybrid IR82367H to 6.57 t ha^{1} for hybrid IR83202H in 2009 (Table 4).

Correlation: The result of correlation analysis as shown by their coefficients of correlation (Table 5), reveal that grain yield exhibited significantly positive correlation with number of panicles per m^2 ($r = 0.59$*), panicle weight ($r = 0.60$*) and number of grains per panicle ($r = 0.52$*) but negatively correlated with days to 50% flowering ($r = -0.51$**) and days to maturity ($r = -0.6$**). Plant height showed significantly positive correlation with days to 50% flowering ($r = 0.65$**) and days to maturity (r = 0.67**). Number of panicles per m^2 correlated positively with the number of tillers per plant (r = 0.54*), panicle weight (r = 0.54*) and grain yield(r = 0.59*). 1000-grain weight did not correlate with any trait under study except panicle length. Correlation between plant height, panicle length, number of tillers per plant and 1000-grain weight were not significant. Number of panicles per m^2, panicle weight and number of grains per panicle appeared to be the main contributors to grain yield in rice. The negative correlation observed between grain yield and days to maturity implied that extra early maturing variety may record low grain yield.

DISCUSSION

The remarkable differences in agronomic performance observed among hybrids, interspecific lowland NERICAs and inbred varieties in all the traits studied is an indication that wide genetic variability exists among them. This suggests that the genetic potential of hybrids, interspecific lowland NERICAs and inbred depend on their parental lines. This agrees with the finding of Virmani and Kumar (2004). The highly significant interactions observed between varieties and seasons in all the traits except panicle weight, number of grains per panicle and 1000 grain weight, show that the genotypes respond differently to different seasons. Yang *et al.* (2008) observed similar results. The number of days to maturity plays a significant role in the cropping system. Early maturing crops are timely handled, evacuate the land early for the next crops and escape from insect pest attack. The distinct variation among hybrids, interspecific lowland NERICAs and inbred and the interaction with season for maturity is an indication that season and parental combination have significant effect on the number of days to maturity. This can be attributed to high solar radiation during the dry season and their genetic make up. The result is in consonance with the findings of Yang *et al.* (2008). However, inbred variety IR77674 recorded the shortest days to maturity and also the lowest grain yield. This confirms the report of Islam *et al.* (2010) that varieties with longer growth duration usually produce more grain yield than the varieties with shorter growth duration. Comparing hybrids, interspecific lowland NERICAs and inbred for plant height, it was observed that hybrids were shorter than the inbred varieties which may be an important character for hybrid to withstand lodging (Malini *et al.*, 2006). The major yield components in rice are number of panicles per unit area, number of grains per panicle, panicle weight and individual grain weight expressed as 1000-grain weight. Hybrids were observed to have significantly out performed both inbred and lowland interspecific NERICAs in number of tillers per plant, number of panicles per $m^{2,,}$ panicle weight, number of grains per panicle and 1000 grain weight. This is an indication that the high yield of hybrid rice might be due to these traits. The present observations are in conformity with the findings of Islam *et al.* (2010). Grain yield was significantly higher in the hybrid than in the inbred and interspecific lowland NERICAs in the two seasons but these differences were more prominent in the dry season than in the wet season. This corroborates the heterosis for higher grain yield reported by Ma and Yuan (2003) and Virmani *et al.* (1982). The high grain yield performance of hybrid rice was observed to be due to high number of panicles per m^2, number of grains per panicle, panicle weight and 1000-grain weight. Grain yield is polygenically controlled and also influenced by many yield-contributing component characters. Hence, direct selection is often misleading. Therefore, establishing the extent of association between yield and its attributes is a very useful tool for successful selection. The positive correlation between grain yield, number of panicles per m^2, panicle weight and number of grains per panicle is an indication that they may be the main contributors to grain yield in rice. The results are in conformity with Babar *et al.* (2007) for number of panicles per plant and Ramakrishman *et al.* (2006) for number of grains per panicle.

CONCLUSION

The study has shown clearly that NERICA-L-19 competed favorably with hybrid rice. The superior performance of two hybrids over the best commercial variety showed clearly that hybrid rice has huge potential in raising rice productivity in Nigeria. Correlation studies indicated that for improvement in rice grain yield, the intensive selection on the positive side should be made for number of panicles per m^2, number of grains per panicle and panicle weight. This is because these traits showed significantly positive correlation not only with grain yield but also among themselves.

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