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Full Length Research Paper

Evaluation of yields of seven upland rice (*Oryzae sativa*) cultivars sown by three methods in Anyigba, Kogi State, Nigeria

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Yield is the characteristic by which a cultivar is commonly judge. A cultivar may be considered satisfactory only if it is able to produce a good yield in comparison to others at various times and in various situations. Trials were conducted in the rainy seasons of 2007 and 2008 at the Kogi State University Teaching and Research Farm (Longitude 07°06[1] N; 43°E), Anyigba, Kogi State, Nigeria to investigate the response of seven cultivars of upland (NERICA 1-7) rice sown by three sowing methods: broadcasting, dibbling and drilling. Treatments consisted of three sowing methods (drilling at 20 cm apart, dibbling at 20 × 20 cm and even broadcasting of seeds) of seven NERICA varieties. Results of statistical analysis revealed that crop establishment responded significantly to sowing method and cultivar. Significant influence of cultivar was also observed on final plant height and paddy yield. Significant interactions (sowing method × cultivar) were observed on establishment count and paddy yield/ha. The combined results of both seasons show that NERICA 5 gave the highest paddy yield. However, considering the individual years, the most consistent cultivar was NERICA 6. Thus, it is recommended for the experimental area.

Key words: Sowing method, establishment count, plant height, tiller formation, paddy yield.

INTRODUCTION

Fashola et al. (2007) observed that the importance of rice in Nigeria is no longer the question, but rather how we can meet the growing demand, reduce import and be self-sufficient. Prior to 1960s rice consumption in Nigeria was principally a ceremonial food used on occasions such as in marriages, naming ceremonies and cultural festivals; however, with growing urbanization this trend has long changed. Presently, rice is a common dietary staple in Nigeria and during most festivals it form part, if not the main dish offered to guests. Ukwungwu et al. (2004) observed that the average Nigerian now consumes 21 kg of rice annually, representing 9% of total caloric intake and 23% of the total cereal consumption, with an estimated 2.1 million tonnes of rice consumed annually by the populace. Although, *Oryzae glaberrima* is indigenous to the country, being cultivated in Sokoto and its environs for centuries, Nigeria still depends on imported rice to meet the daily rice consumption of its increasing population. An estimated 0.4 million tonnes of rice enters the country annually (Ukwungwu et al., 2004). Undoubtedly, no other staple has enjoyed such patronage as imported rice. The product has often enjoyed government subsidy until very recently. Imported rice is usually viewed as superior to local varieties, basically as a result of its quality; quality in terms of absence of stones and grain lengths.

There exist huge potential for rice cultivation in Nigeria, either as upland, swampy or irrigated rice. Unlike most other crops, rice lends itself to two methods of stand establishment: transplanting and direct seeding. When rice is seeded directly, seeding methods vary among farmers from broadcasting, dibbling to crop drilling as determined by available technology and machinery. However, broadcasting has been reported to reduce plant

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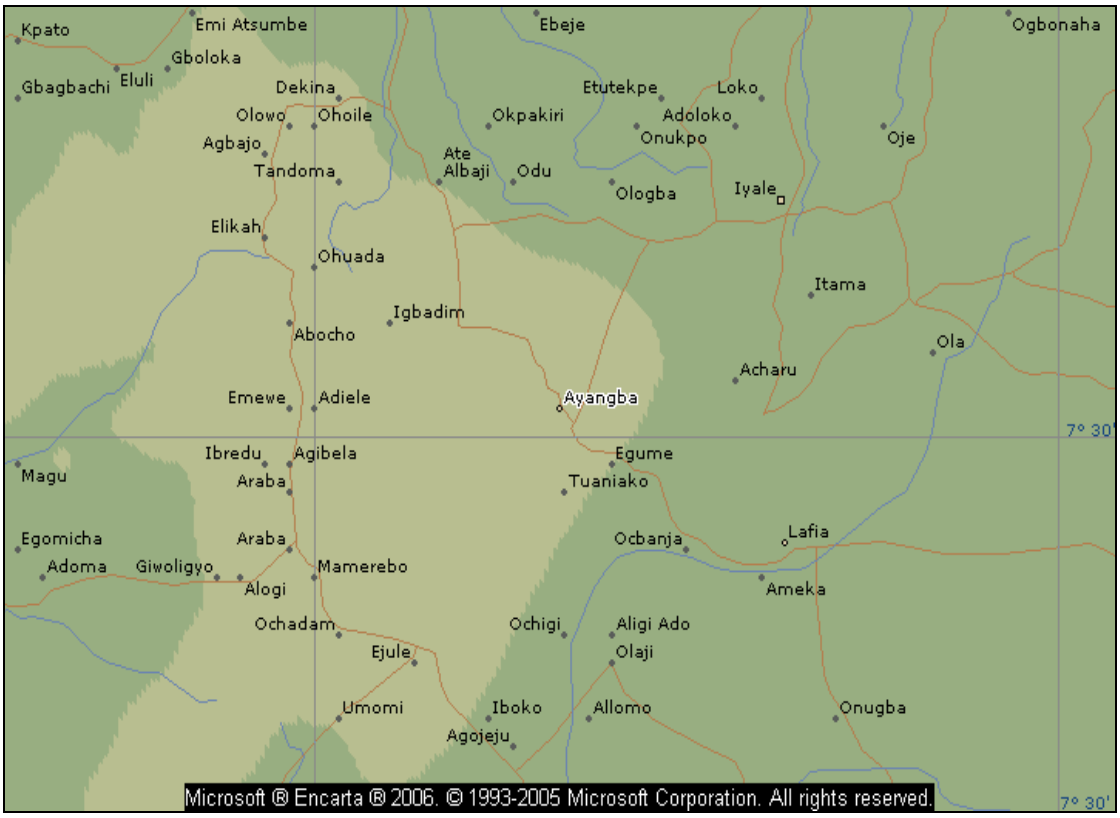

Figure 1. Map showing Anyigba (Anyagba) in Kogi state, Nigeria.

establishment as seeds are said to be lost to pests and unfavourable weather conditions. Consequently, high seed rates have been recommended when seeds are broadcast in order to compensate for seed loss. It was stressed that, broadcasting, even when followed by harrowing or raking does not bring seed in perfect contact with the soil for adequate water uptake necessary for seed germination to occur. Though, better crop yields as a result of better crop establishment has been reported when rice or other crops are drilled compared to other sowing methods, drilling is an expensive technology in the form of labour requirements or machinery for seed drilling. Thus, seed broadcasting or dibbling is often prevalent on farmers' plots.

Lightfoot (1985) cited in Perrot-Maitre and Weaver (1992) wrote that indigenous research is a viable resource for developing on-farm experimental methods that promote farmer participation in adopting technologies to specific farming conditions and providing feedback on basic research needs. Drawing from farmers' practices, this research thus focused on assessing the impact of common sowing method in rice cultivation among Nigerian farmers on seven upland rice cultivars. The trial assessed some growth, yield components and paddy yield of seven NERICA cultivars sown by three sowing methods with a view to ascertaining the most adapted cultivar based on crop yield and to recommend the most appropriate NERICA cultivar for the experimental area.

MATERIALS AND METHODS

Trials were conducted in the rainy seasons of 2007 and 2008 at the Kogi State University Teaching and Research Farm (Longitude 07° 06[1]N; 43°E) Anyigba (Figure 1), Kogi State, Nigeria to investigate the yield response of seven cultivars of upland (NERICA 1-7) rice sown by three sowing methods: broadcasting, dibbling and drilling. Treatments consisted of three sowing methods (drilling at 20 cm apart, dibbling at 20 cm × 20 cm and even broadcasting of seeds) of seven NERICA cultivars sown on the flat.

The trial, a randomized complete block design (RCBD) was laid out in a factorial experiment with three replications. Sub plot size of 3 × 5 m (15 m^2) with net plot of 10 m^2 for data collection was employed. Each cultivar was seeded at 120 kg/ha and the plot treated with N, P_2O_5 and K_2O and broadcast at the rate of 60 – 30 - 30 kg/ha. Hoe weeding was carried out at 3, 6, and 9 weeks after sowing (WAS).

Data collected included establishment count/m^2 at 2 WAS, number of tillers/m^2, final plant height and paddy yield/ha. Data on plant establishment and tiller counts were the average of three quadrate (30 × 30 m) throws. At maturity, all plants in the net plot (10 m^2) were manually harvested, bound, manually threshed, winnowed and the recovered paddy weighed to obtain paddy yield/ha. Data generated were subjected to analysis of variance using SAS computer statistical package (SAS Institute, 1996) as described for RCBD. Treatments means found to be statistically significant ($p < 0.05$) were compared using Duncan Multiple Range Test as described for RCBD.

Table 1. Plant establishment in seven cultivars of rice sown to three sowing methods in Anyigba, Kogi State, Nigeria.

Treatment	Establishment count/m^2		
	2007 cropping season	2008 cropping season	Combined data
Sowing method			
Broadcast (S1)	107^{c}	96^{c}	102^{c}
Dibbling (S2)	189^{a}	139^{a}	164^{a}
Drilling(S3)	154b	104b	129b
SE±	9.9	7.4	6.8
Cultivar			
NERICA 1	67^{d}	108^{c}	88^{c}
NERICA 2	100^{c}	33^{f}	67^{d}
NERICA 3	92^{c}	25^{g}	59^{e}
NERICA 4	375^{a}	208^{b}	292^{a}
NERICA 5	92^{c}	100^{d}	96^{b}
NERICA 6	25^{e}	75^{e}	50^{f}
NERICA 7	342^{b}	258^{a}	300^{a}
SE±	3.3	2.1	1.8
Sowing method × cultivar			
Broadcasting			
NERICA 1	25^{j}	75g	50^{l}
NERICA 2	125^{g}	50^{h}	75^{k}
NERICA 3	50^{i}	25^{i}	38^{m}
NERICA 4	175^{e}	200^{d}	188^{f}
NERICA 5	125^{g}	75^{g}	100^{i}
NERICA 6	25^{j}	25^{i}	25^{n}
NERICA 7	225^{d}	225^{c}	225^{e}
Dibbling			
NERICA 1	25^{j}	200^{d}	113^{h}
NERICA 2	125^{g}	25^{i}	75^{k}
NERICA 3	75^{h}	25^{i}	50^{l}
NERICA 4	600^{a}	175^{e}	388^{b}
NERICA 5	25^{j}	75^{g}	50^{l}
NERICA 6	25^{j}	150^{f}	88^{j}
NERICA 7	450^{b}	375^{a}	413^{a}
Drilling			
NERICA 1	150^{f}	50^{h}	100^{i}
NERICA 2	50^{i}	25^{i}	38^{m}
NERICA 3	25^{j}	25^{i}	25^{n}
NERICA 4	350^{c}	250^{b}	300^{c}
NERICA 5	125^{g}	150^{f}	138^{g}
NERICA 6	25^{j}	50^{h}	38^{m}
NERICA 7	350^{c}	175^{e}	263^{d}
SE±	3.2	2.6	2.1

RESULTS

Data for both cropping seasons (2007 and 2008) and the combined result of the two seasons revealed significant ($p < 0.05$) effects of cultivar, sowing method and their interactions on rice establishment in Anyigba, Kogi State, Nigeria (Table 1). Dibbling rice resulted in significantly ($p < 0.05$) higher stand counts compared to broadcast and drilling. The least mean establishment counts; 107 and 96 plants/m^2 respectively, in 2007 and 2008, were in

Table 2. Final plant height in seven cultivars of rice sown to three sowing methods in Anyigba, Kogi State, Nigeria.

Treatment	Final plant height		
	2007 cropping season	2008 cropping season	Combined data
Sowing method			
Broadcast (S_3)	128.7	128.6	128.7
Dibbling (S_1)	118.6	118.5	118.6
Drilling(S_2)	115.5	111.9	113.7
SE±	19.21 ns	18.11 ns	18.51 ns
Cultivar			
NERICA 1	114.0	109.0	111.5
NERICA 2	110.3	101.5	105.9
NERICA 3	131.3	136.7	134.0
NERICA 4	115.2	129.3	122.3
NERICA 5	111.5	120.1	115.8
NERICA 6	127.7	125.5	126.6
NERICA 7	135.3	161.0	148.2
SE±	12.78 ns	17.32 ns	16.22 ns
Sowing method × cultivar			
Broadcasting			
NERICA 1	114.0	111.3	112.7
NERICA 2	112.5	105.0	108.8
NERICA 3	139.0	138.1	138.6
NERICA 4	132.9	134.5	133.7
NERICA 5	116,1	118.7	117.4
NERICA 6	135.0	130.7	132.9
NERICA 7	151.4	161.9	156.7
Dibbling			
NERICA 1	121.0	110.3	115.7
NERICA 2	121.7	126.0	123.9
NERICA 3	127.0	128.7	127.9
NERICA 4	116.8	117.0	116.9
NERICA 5	108.5	109.4	109.0
NERICA 6	112.0	119.0	115.5
NERICA 7	123.1	118.9	121.0
Drilling			
NERICA 1	107.0	112.0	109.5
NERICA 2	98.0	98.5	98.3
NERICA 3	128.0	105.0	116.5
NERICA 4	97.5	100.0	98.8
NERICA 5	110.0	117.0	113.5
NERICA 6	136.0	114.0	125.0
NERICA 7	132.0	137.0	135.0
SE±	13.44 ns	12.11 ns	11.54 ns

ns: Not significantly different at 5%.

broadcast plot. The combined results of both seasons followed the same trend as the individual years, with broadcast plot recording significantly the lowest plant establishment (102 plants/ m^2), as compared with 164 plants/ m^2 in dibbled plot and 129 plant/m^2 in drilled plot. However, the result of data analysis reveals that sowing

method and cultivar did not significantly ($p > 0.05$) influence final plant height and paddy yield in both cropping seasons and in the combined results (Tables 2 and 4).

DISCUSSION

Effects of sowing method, cultivar and their interactions on plant establishment

For germination to occur in seeds there is the need for seeds to be in perfect contact with the soil to facilitate water uptake (Chapman and Carter, 1976). Broadcasting does not bring seed in perfect contact with the soil for water uptake (Chapman and Carter, 1976), which must have accounted for the observed reduction in mean stand count among broadcast plots in comparison with the other sowing methods investigated in this trial. Inadequate seed burial in broadcast plots is the main factor responsible for low establishment count, as broadcasting has been found to place seeds at disadvantage as shallow planting results in drying of soil before the seeds germinate (Whiteman, 1993). Inadequate seed burial also encourages seed losses due to pest interference, as ants pick exposed seeds; a conclusion which was also reached by other researchers (Chapman and Carter, 1976; Hay and Walker, 1989; Kipps, 1983; Oyewole et al., 2001; Oyewole et al., 2007; Rowland and Whiteman, 1993) who reported that broadcasting depress seed germination and consequently crop establishment as seeds are said to be lost to incidence of pests, diseases and other environmental influence. The result of statistical analysis showed that the significant ($p < 0.05$) cultivar effect on stand counts was contrary to the observed non significant effect of variety on wheat stand count as reported by Oyewole et al. (2005). However, other researchers observed that crop emergence and establishment are affected by variety traits (Rowland and Whiteman, 1993); where seed germination was reported to decrease with increased seed age, which varied within crop variety. That varieties differ in their response to environmental conditions (Kipps, 1983) may have accounted for the observed cultivar influence on crop establishment in both seasons and in the combined results. Differences in seed size among the different NERICA cultivars studied must have had impact on seed germination, vigour and consequently on seedling establishment; as the bigger the seed size, the more the food reserve and the greater the prospect for germination and establishment.

The significant (sowing method × cultivar) interaction effects may have been as a result of the highly significant effect of cultivar on the measured parameters, rather than the expression of the individual cultivar as moderated by sowing method. For example, considering the combined result of both seasons, there is a wide margin between the establishment count observed in NERICA 6 (50 plants/m^2) and that obtained in NERICA 7 (300 plants/m^2), or between establishment count observed in NERICA 4 and NERICA 6. These wide margins were enough to impact the result of sowing method, thus ensuring interaction effects. NERICA 4 and 7 consistently gave good establishment count in both seasons as against other cultivars investigated. The highest establishment count for NERICA 1 was obtained when the cultivar was drilled and the least response was when it was broadcasted. The highest establishment response for NERICA 2 was in broadcasting and dibbling while the least response was obtained when the cultivar was drilled. NERICA 3 responded best to dibbling and least to drilling, while NERICA 4 responded most to dibbling and least to broadcasting. The highest establishment count for NERICA 5 was when the cultivar was drilled. The best establishment response for NERICA 6 was in dibbling, while the best response for NERICA 7 was also obtained in dibbled plot. The implication of these is that the individual responses to the various sowing methods should be put into consideration in selecting the most appropriate sowing method to be adopted.

Effects of sowing method, cultivar and their interactions on final plant height, tiller formation and paddy yield

The importance of determining the impact of sowing method on plant height is underpinned by the fact that cereal crops tend to lodge above certain height. Ordinarily, the primary effect of increasing plant population either by varying seed rates or sowing method is an increase in competition between adjacent plants (Hay and Walker, 1989). The resulting shading of plant tissues increase the level of gibberellins; the overall effects are the promotion of leaf sheath and blade extension and the acceleration of crop development process. However, the significant ($p < 0.05$) effect of sowing method and cultivar on establishment counts, which would have impacted a positive response on final plant height were countered by profuse tiller formation in those plots and cultivars, which were at a disadvantage in respect to stand counts, thus nullifying their effects.

Since rice possesses the ability of tiller, and the tendency for tiller to increase with reduction in plant population/unit area of land (Kipps, 1983), reduction in plant establishment count witnessed in broadcast plot was masked by increase in tiller formation in the treatment (Table 3) resulting in a non significant ($p > 0.05$) effect of sowing method on total paddy yield per hectare (Table 4). The observed non significant effect of sowing method on paddy yield lends support to previous observations made by Graham and Ellis (1980), Oyewole et al. (2001), Oyewole et al. (2005), that broadcast cereal crops could yield as high as drilled cereals under similar

Table 3. Plant population/m^2 after tiller formation in seven cultivars of rice sown by three sowing methods in Anyigba, Kogi State, Nigeria.

Treatment	Tillers /m^2		
	2007 cropping season	2008 cropping season	Combined data
Sowing method			
Broadcast (S1)	332	450	391
Dibbling (S2)	302	416	359
Drilling(S3)	344	442	393
SE±	15.9 ns	22.2 ns	17.7 ns
Cultivar			
NERICA 1	335^{d}	412^{ab}	374^{c}
NERICA 2	400^{c}	165^{d}	283^{d}
NERICA 3	432^{b}	161^{d}	297^{d}
NERICA 4	531^{a}	421^{a}	476^{a}
NERICA 5	413^{bc}	398^{b}	406^{b}
NERICA 6	150^{e}	267^{c}	209^{e}
NERICA 7	542^{a}	397^{b}	470^{a}
SE±	6.8	7.2	5.7
Sowing method x cultivar			
Broadcasting			
NERICA 1	334^{c}	431^{a}	383^{c}
NERICA 2	366^{b}	308^{d}	337^{e}
NERICA 3	382^{b}	306^{d}	344^{e}
NERICA 4	432^{a}	436^{a}	434a
NERICA 5	373^{b}	424^{ab}	399^{c}
NERICA 6	241^{ef}	359^{c}	300f^{g}
NERICA 7	437^{a}	424^{ab}	431^{a}
Dibbling			
NERICA 1	319^{d}	414^{ab}	367^{d}
NERICA 2	351^{c}	291^{d}	321^{ef}
NERICA 3	367^{b}	289^{d}	328^{e}
NERICA 4	417^{a}	419^{ab}	418^{ab}
NERICA 5	358^{b}	407^{b}	383^{cd}
NERICA 6	226^{f}	342^{c}	284^{g}
NERICA 7	422^{a}	407^{b}	415^{a}
Drilling			
NERICA 1	340^{c}	427^{ab}	384^{c}
NERICA 2	372^{b}	304^{d}	338^{e}
NERICA 3	388^{b}	302^{d}	345^{e}
NERICA 4	438^{a}	432^{a}	435^{a}
NERICA 5	379^{b}	420^{ab}	400b^{c}
NERICA 6	247^{e}	355^{c}	301^{f}
NERICA 7	443^{a}	420^{ab}	432^{a}
SE±	6.8	7.2	5.7

Means within the same treatment followed by unlike letter(s) are significantly different at 5%; ns: not significantly different at 5%.

agronomic conditions; with crops tiller. Moreover, Sim (1983) observed that cereals achieved maximum yield at relatively low population densities, on some cases below 200 plants /m^2. There was, however, significant ($p < 0.05$)

Table 4. Paddy yield in seven cultivars of rice sown to three sowing methods in Anyigba, Kogi State, Nigeria.

Treatment	Paddy yield (kg/ha)		
	2007 Cropping season	2008 Cropping season	Combined data
Sowing method			
Broadcast (S_3)	3000	2671	2836
Dibbling (S_1)	3357	2800	3079
Drilling(S_2)	3029	2757	2893
SE±	122.3 ns	132.8 ns	134.7 ns
Cultivar			
NERICA 1	2833^{b}	2667^{c}	2750^{d}
NERICA 2	2833^{b}	2733^{bc}	2783^{d}
NERICA 3	3167^{b}	2700^{bc}	2934^{bc}
NERICA 4	3000^{b}	2767^{bc}	2884^{c}
NERICA 5	4167a	2467^{c}	3317^{a}
NERICA 6	2900^{b}	3200^{a}	3050^{abc}
NERICA 7	3000^{b}	2667^{c}	2834^{c}
SE±	142.3	131.3	123.4
Sowing method × cultivar			
Broadcast			
NERICA 1	3000^{c}	2600^{cd}	2800^{e}
NERICA 2	3000^{c}	2500de	2750de
NERICA 3	3000^{c}	2500de	2750de
NERICA 4	3000	2900^{b}	2950^{c}
NERICA 5	3000^{c}	2400^{e}	2700^{e}
NERICA 6	3000^{c}	3200^{a}	3100^{c}
NERICA 7	3000^{c}	2600cd	2800^{d}
Dibbled			
NERICA 1	2500^{c}	3000^{b}	2750^{d}
NERICA 2	3000^{c}	2500de	2750^{d}
NERICA 3	2500^{c}	3000^{b}	2750^{d}
NERICA 4	3000^{c}	2700^{c}	2850^{d}
NERICA 5	7000^{a}	2500de	4750^{a}
NERICA 6	2500^{c}	3200^{a}	2850^{d}
NERICA 7	3000^{c}	2700^{c}	2850^{d}
Drilling			
NERICA 1	3000^{c}	2400^{e}	2700^{e}
NERICA 2	2500^{c}	3200^{a}	2850^{d}
NERICA 3	4000^{b}	2600^{cd}	3300^{b}
NERICA 4	3000^{c}	2700^{c}	2850^{d}
NERICA 5	2500^{c}	2500^{d}	2500^{f}
NERICA 6	3200^{c}	3200^{a}	3200^{bc}
NERICA 7	3000^{c}	2700^{c}	2850^{d}
SE±	42.3	41.9	36.4

Means within the same treatment followed by unlike letter(s) are significantly different at 5%; ns: not significantly different at 5%.

cultivar effect on paddy yield, with the highest paddy yield observed in NERICA 5 (combined results of both cropping seasons), while the least paddy yield was in NERICA 1.

Conclusion

Yield is the characteristic by which a cultivar is commonly judged. A cultivar may be considered satisfactory only if it is able to produce a good yield in comparison to others. In this respect, based on paddy yield obtained, NERICA 5 should have been recommended for the experimental area to be dibbled or drilled as these sowing methods gave the best yield responses. However, there is the need to apply caution in recommending the most suitable cultivar for the experimental as data obtained in 2007 cropping season was not consistent with that of 2008. While dibbling NERICA 5 gave the best yield in 2007, the same could not be said of the same treatment in 2008. Thus, the observed result may have been a coincidence. The most consistent cultivar was NERICA 6, which incidentally gave the most comparable paddy yield in comparison with NERICA 5 (see the combined paddy yield data). NERICA 6 is thus, recommended for the experimental area. There may, however, be need for further confirmation of this recommendation to ascertain the consistency or superiority of NERICA 6 in comparison with other cultivars. Generally, result on paddy yield indicated that farmers using any of the sowing methods investigated may not be at a disadvantage as reduction in stand counts may be compensated for by increase in tiller formation and other yield components resulting in non significant effect of sowing method on crop yield.

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