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Performance of Lowland Rice (*Oryza sativa L*) as Affected by Transplanting Age and Plant Spacing in Abakaliki, Nigeria

*Nwokwu, G.N
Department of Crop Production and Landscape Management, Faculty of Agriculture and Natural Resources Management, Ebonyi State University, P.M.B 053, Abakaliki, Nigeria.
* E-mail: g.nwokwu@yahoo.com.

Abstract
The field experiment was conducted at the Rresearch Field of the Faculty of Agriculture and Natural Resources Management Ebonyi State University, Abakaliki during 2010 and 2011 farming seasons, to investigate the effect of transplanting age and plant spacing on the growth and yield of lowland rice (*Oryza sativa* L*)*. The treatments were four transplanting ages (2, 4, 6 and 8 week's old plants) and three levels of plant spacing (20cm x 20cm, 30cm x 30cm and 40cm x 40cm). The treatments were laid as a 4 x 3 factorial experiment in a randomized complete block design (RCBD) and were replicated four times. The results revealed that four week's old plant produced the tallest plants, more number of tillers, leaf area index, number of panicles, longest of panicles and paddy yield while the least number of leaves, number of tillers, days to 50% heading, number of panicles, 1000 grain weight and paddy yield were recorded at eight weeks old plant. However, plant spacing of 40cm x 40cm produced highest number of tillers, number of leaves, days to 50% heading and 1000 grain weight. Whereas, plant spacing of 30cm x 30cm recorded longest panicle, more number of panicle and paddy yield. This result showed that four weeks old plant with 30cm x 30cm demonstrated the highest paddy yield and can be recommended for rice production in the study area.
Key words: Transplanting age, plant spacing, Rice, growth and yield.

1.Introduction

The genus oryza belongs to the Poaeceae family and there are two cultivated species of the genus of which *Oryza sativa* L is of Asian and *Oryza glaberrima* is of African origin (Clayton and Renvoize, 1986). The species comprises numerous ecotypes or geographical races and is categorized into *indica* and *japonica* which is mainly on the basis of their morphological and physiological characters. Rice is the most widely cultivated cereal crop in the world after wheat and it is the most important food crop for almost half of the world population (Schalbroeck, 2001). Rice as a staple food and is rich in energy, very low in fat and contains no cholesterol; sugar free and alutein free (Nwakpu, 2003). Rice is cultivated in almost all the ecological regions of the world, especially between latitude 53^0N and 30^0S and with an estimated world production of 562 million metric ton in 2000 (FAO 1998).

Rice, like other agricultural crops, has some production problems in Nigeria, Some of the problems are social and political; others are scientific and technological. Most of the social and technological problems involve government policies, pest and disease and more importantly is that most farmers are illitrate and they lack the knowledge of cultural practrices such as establishment methods, spacing, time of planting /fertiliozer application (Garba *et al*; 2013). Most farmers are not aware of any plant spacing while others unsystematically plant their rice without considering any spacing which result in poor paddy yield due high competition for space, light, water and nutrients. The use of 30 x 30 cm inter and intra row spacing has been suggested for optimum rice production. However, no clear specification about spacing was drawn for this study area.which depend mainly on either it low tillering upland or high tillering lowland rice. Some rice varieties are lower in their tiller production than others, hence the need for different spacings and for different spacies (NCRI, 2005).

Rice establishment age is also one of the key prerequisite for achieving desired level of rice production through optimum leaf area and shape to maximize photosynthetic efficiency as well as developed root system and tillering ability (Sun *et al*., 1999). Rice is a photo-period sensitive crop, too low or high temperature adversely affects the spike fertility. It responds to variation in day length and intensity in different periods (Manhan and Siddique, 1990). It is important to consider seedling age which will in turn contribute toward increased rice production and resolve the problem posed by higher temperature, which could have resulted in low population per unit area and as well causing huge economic losses to the farming community in the tropics (Adak and Gupta, 2002). Therefore, for successful rice production, timely planting, suitable transplanting densities for optimum tillering and control of leaf growth by controlling water, fertilizer and chemical inputs through spacing are essential for improving the growth variables responsible for higher yield (Ghosh and Singh, 1998).

Therefore, the objective of this study was to determine the effect of transplant age and plant spacing on growth and yield of lowland rice.

2. Materials and Methods

The field experiment was conducted at the research field of faculty of Agriculture and Natural Resources Management, Ebonyi State University Abakaliki. The treatments used were four transplant ages (2, 4, 6 and 8 week's old plants planted in the nursery) and three plant spacing (20 cm x 20 cm, 30 cm x 30 cm, 40 cm x 40 cm). The treatments were laid as a 4 x 3 factorial experiment in a Randomized Complete Block Design (RCBD) and were replicated four times. The experimental field measured 30 m x 12 m making a total area of 360 m^2. The area was tilled, levelled manually with hoe. Each plot measured 2 m x 2 m (4 m^2) with 0.5m space between plots and 1m between replicates/block. The nursery was raised using dry bed method in a well-drained soil close to low land site for ease watering and transplanting. Transplanting of rice seedling was carried out after 2, 4, 6 and 8 weeks respectively on a well ploughed land. Also during transplanting, planting spacing of 20 cm x 20 cm, 30 cm x 30 cm, 40 cm x 40 cm was considered as well. However, 80 kg ha^{-1} of 15: 15: 15 NPK compound fertilizer was applied two weeks after transplanting as a basal treatment. The experimental site was kept weed free throughout the duration of the experiment and other agronomic practices were duly carried out. Data were collected at 4, 8 and 12 weeks on growth, yield and yield attributing characters from ten tagged plants randomly selected from the net plots. The paddy yield was estimated at 14% moisture level. All the data collected were subjected to analysis of variance. Comparison of treatment means were done using the F-LSD procedure (Obi 1982)

3. Results and Discussion

The result showed that transplanting age increased from two weeks old plant to four weeks old plant and then decreased through six weeks old plant to eight weeks old plant Table 1. Although, there were no significant effect among the treatments on plant height, the tallest plants (104.25) were recorded at four weeks transplant age while the shortest plants (93.77) were at two weeks old seedling. The non significant response of plant ages could be due to availability of soil nutrient which favoured the growth and development of the at all ages. Similarly, Faruk *et al.* (2009) reported that the highest plant height was recorded from four weeks old seedling while the least was obtained at two weeks old seedling. Plant spacing equally recorded non-significant difference (P>0.05) on plant height. The tallest plants were obtained at 20 cm x 20 cm plant spacing (100.51) while the shortest plants were obtained at 30cm x 30 cm (97.81). Interaction of transplant age and plant spacing was also not significant (P>0.05) on plant height. The tallest plants were at four weeks old seedling and 30cm x 30cm spacing (105.90) while the shortest plants were at two weeks old seedling and 30cm x 30cm plant spacing (86.55).

Table 1: Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on plant height (cm).

Treatments	**plant spacing (cm)**			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	99.90	86.55	94.87	93.77
Four weeks old plant	101.05	105.90	105.80	104.25
Six weeks old plant	105.15	97.35	99.20	100.55
Eight weeks old plant	95.97	101.47	99.12	96.85
Means	100.51	97.81	99.74	

F-LSD (P=0.05), Transplanting Age =ns, Plant Spacing=ns, Transplanting age x planting spacing =n**.**

From the result, it was observed that transplant age produced significant difference (P<0.05) on number of leaves. The number of leaves per hill increased from two weeks old seedling to four weeks old seedling and beyond four weeks, there was a decrease (Table 2). The highest number of leaves per hill was obtained at four weeks old seedling (128.00) and the least number of leaves pert hill were at eight weeks old seedling (94.63) and they differed significantly (P<0.05). Khusrul and Aminu, (2009) stated that the overall performance (growth, yield and yield contributing characters) of indigenous varieties were better with 35 days old seedling. More so, significant difference was produced among various plants spacing studied. The number of leaves per hill increased as the plant spacing increases. Plant spacing of 40cm x 40cm produced the highest number of leaves per hill (111.47) while 20 cm x 20 cm produced the least number of leaves per hill (85.17) and they differed significantly (P<0.05). Baloch *et al.* (2002) equally proved that wider spacing had linearly increasing effect on the performance of individual plants. Transplant age x plant spacing interaction were not significant (P>0.05) on the number of leaves per hill. The highest number of leaves per hill was obtained at four weeks old seedling and plant spacing of 30 cm x 30 cm (151.90) while the least value was at six weeks old seedling and plant spacing of 20 cm x 20 cm spacing (66.95).

Table 2: Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on number of leaves.

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	94.00	90.80	110.30	98.36
Four weeks old plant	96.89	151.90	131.00	128.00
Six weeks old plant	66.95	104.40	114.20	95.85
Eight weeks old plant	82.95	96.80	104.50	94.63
Means	85.17	111.47	116.41	

F-LSD (P=0.05), Transplanting Age =15.43, Plant Spacing=13.36, Transplanting age x planting spacing =ns

Transplant age had significant effect (P<0.05) on the number of tillers per plant (Table 3). The number of tillers increased from two weeks old seedling to four weeks old seedling beyond which there was a decrease. The highest number of tillers per plant was obtained at four weeks old seedling (26.10) while the least number of tillers per plant was at eight weeks old seedling (15.76) and they differed significantly (P<0.05). Ashraf *et al.* (1999) gave similar result. It was reported that seedling age of 25 to 35 days old produced significantly higher number of tillers, productive tiller per plant, paddy and straw yields as compared with 55 days old seedlings. However, number of tillers increased as the plant spacing increases. Plant spacing of 40cm x 40cm produced the highest number of tillers (23.04) while 20cm x 20cm spacing gave the least number of tillers per plant (15.47) and they differed significantly (P<0.05).

The interaction between transplant age and plant spacing levels did not significantly affect number of tillers per plant. However, the highest number of tillers was at four weeks old seedling and plant spacing of 30cm x 30cm (30.20) while the least number of tillers was at eight weeks old seedling and plant spacing of 20cm x 20cm (11.45).

Table 3:Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on number of tillers.

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	17.40	17.75	24.32	19.82
Four weeks old plant	19.40	30.20	28.70	26.10
Six weeks old plant	13.65	21.55	22.00	19.06
Eight weeks old plant	11.45	18.70	17.15	15.76
Means	15.47	22.05	23.04	

F-LSD (P=0.05),Transplanting Age =3.73, Plant Spacing=3.27, Transplanting age x planting spacing =ns

The result revealed that transplant age recorded non-significant differences (P>0.05) on the leaf area index (Table 4). The highest leaf area index was obtained at four weeks old seedling (6.33) and the least was at six weeks old seedling (4.56). In this study, it was observed that plant spacing produced significant difference (P<0.05) on leaf area index and that leaf area index decreased as plant spacing increases. Plant spacing of 20 cm x 20 cm produced the highest leaf area index (8.44) while plant spacing of 40 cm x 40 cm produced the least leaf area index (2.73) and they differed significantly. Transplant age x plant spacing interaction was non-significant (P>0.05) on leaf area index. The highest leaf area index value was at four weeks old seedling and plant spacing of 20 cm x 20 cm (10.02) while the least was at two weeks old seedling and 40cm x 40cm plant spacing (2.21).

Table 4: Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on leaf area index.

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	9.34	3.21	2.21	4.92
Four weeks old plant	10.02	5.18	3.80	6.33
Six weeks old plant	6.91	4.25	2.54	4.56
Eight weeks old plant	7.50	4.08	2.40	4.66
Means	8.44	4.18	2.73	

F-LSD (P=0.05),Transplanting Age =ns, Plant Spacing=1.28, Transplanting age x planting spacing =ns

Transplant age recorded significant difference (P<0.05) on Day to 50% heading (Table 5). The number of days from planting to heading decreased from two weeks to eight weeks old plant. The two weeks old seedling took more days to head (86.91) while eight weeks old seedling took few days to head (81.58) and they were statistically different (P<0.05).This is expected since early transplanted seedling (two and four weeks old seedling) had more time in the field for its developmemt and translocation of assmiliates than the late transplanted seedlings that had less time for its development. The spacing of 40cm x 40cm recorded more number of days to heading (85.37) while 20 cm x 20 cm plant pacing recorded few days to heading (83.06) and were significantly different (P<0.05). The few days recorded at a closer spacing of 20 cm x 20 cm was due to intra competition for space, soil nutrient, sunlight and water which resulted to stress while the reverse is the case in wider spacing. However, transplant age x plant spacing interaction were not significant (P>0.05). The highest number of days from planting to heading was recorded at two weeks old seedling and 40cm x 40cm spacing (87.75) while the least number of days from planting to heading was at eight weeks old plants and 20 x20cm (80.00)

Table 5:Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on days to 50% heading.

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	86.25	86.75	87.75	86.91
Four weeks old plant	85.00	85.50	86.25	85.50
Six weeks old plant	81.00	83.50	84.50	83.00
Eight weeks old plant	80.00	81.75	83.00	81.58
Means	83.06	84.31	85.37	

F-LSD (P=0.05),Transplanting Age =1.04, Plant Spacing=1.26, Transplanting age x planting spacing =ns

Ttransplanting age had non-significant effect (P>0.05) on panicle lenght (Table 6). The longest panicle (cm) was obtained at four weeks old seedling (29.10) while the shortest panicle was at eight weeks old seedling (27.30). More so, plant spacing produced non-significant effect (P>0.05) on the panicle lenght. The longest panicle (cm) was at 30cm x 30cm plant spacing (28.65) while the shortest panicles were obtained at plant spacing of 20 cm x 20 cm (28.11). Also, transplant age x plant spacing interaction were also not significant (P>0.05) on length of panicle. The longest panicle was recorded at four weeks old seedling and planting spacing of 30cm x 30cm (29.65) and the shortest panicle was at eight weeks old seedling and 20cm x 20cm plant spacing (26.75).

Table 6 Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on panicle length (cm).

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	27.25	29.45	28.05	28.25
Four weeks old plant	28.85	29.65	28.80	29.10
Six weeks old plant	29.60	27.90	29.10	28.86
Eight weeks old plant	26.75	27.60	27.55	27.30
Means	28.11	28.65	28.37	

F-LSD (P=0.05),Transplanting Age =1.04, Plant Spacing=1.26, Transplanting age x planting spacing =ns

The ability of rice to produce panicle per hill differed significantly with transplant age. The number of panicle per hill increased as the transplant age increases up to four weeks from which there was a decrease. Among the ages, four weeks old seedling produced more number of panicles (23.37) than any other plant ages. The least value was recorded from eight weeks old seedling (13.72) and they differed significantly (P<0.05). The number of panicle increased as the plant spacing increases. The spacing of 40cm x 40cm produced the highest number of panicle per hill (21.11) while the plant spacing of 20cm x 20cm gave the least number of panicle (12.61) and they differed significantly (P<0.05). The interaction effect of transplant age and plant spacing did not differ significantly among number of panicle studied. The highest number of panicle was at four weeks of age and 30cm x 30cm plant spacing (26.70) while the least was at eight weeks of age and 20cm x 20cm plant spacing (9.81).

Table 7:Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on number of panicles.

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	11.80	15.98	21.98	16.61
Four weeks old plant	16.80	26.70	26.63	23.37
Six weeks old plant	16.98	19.55	20.05	17.19
Eight weeks old plant	9.81	15.55	15.80	13.72
Means	12.61	19.44	21.11	

F-LSD (P=0.05),Transplanting Age =2.99, Plant Spacing=2.59, Transplanting age x planting spacing =ns

Transplant age was not significantly different (P>0.05) on the number of spikelets per panicle (Table 8).Among the various ages, six weeks old seedling produced the highest number of spikelets per panicle (66.83) and the least was recorded at eight weeks (46.77). Also, plant spacing had significant effect (P<0.05) on the number of spikelets per panicle. Number of spikelets per panicle increased from 20cm x 20cm to 30cm x 30cm and beyond 30 x 30 cm, number of spikelets decreased. The highest number of spikelets per panicle was obtained at 30cm x 30cm spacing (68.37) while the least was at 20cm x 20cm plant spacing (60.68) and they differed significantly (P<0.05). Transplant age x plant spacing interaction were equally not significant (P>0.05). The highest number of spikelets per panicle was at six weeks old seedling and 30m x 30cm spacing (71.75) while the least were at two weeks old seedling and 20cm x 20cm spacing (46.87).

Table 8:Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on number of spikelets per plant..

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	46.87	62.75	68.25	59.29
Four weeks old plant	63.37	70.50	61.75	65.20
Six weeks old plant	67.50	71.75	61.25	66.83
Eight weeks old plant	65.00	68.50	61.82	46.77
Means	60.68	68.37	63.26	

(P=0.05),Transplanting Age =ns, Plant Spacing=7.30, Transplanting age x planting spacing =ns

Transplant age recorded non-significant effect (P>0.05) on 1000 grain weight. Among the ages involved, six weeks old seedling produced the heaviest 1000 grains (32.11g while the least was at eight weeks old seedling (31.43). Also, plant spacing produced non-significant difference (P>0.05) on 1000 grain weight. The heaviest 1000 grains were obtained at 40 cm x 40 cm spacing (31.86) while the least were at 30 cm x 30 cm spacing (31.67). Transplant age x plant spacing interaction were non-significant (P>0.05) on 1000 grain weight. The heviest 1000 grain was at two weeks of age and 40 cm x 40 cm spacing (32.35) while the least were at eight weeks old seedling and plant spacing of 20 cm x 20 cm and 30 cm x 30 cm (31.42) respectively.

Table 9: Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on 1000 grain weight.

Treatments	plant spacing (g)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	31.62	31.52	32.35	31.83
Four weeks old plant	31.52	31.77	31.64	31.64
Six weeks old plant	32.34	31.97	32.02	32.11
Eight weeks old plant	31.42	31.42	31.45	31.43
Means	31.72	31.67	31.86	

F-LSD (P=0.05),Transplanting Age =ns, Plant Spacing=ns, Transplanting age x planting spacing =ns

The result showed that transplanting age had significant effect (P<0.05) on the paddy yield (Table 10). The paddy yield increased as the transplantlng age increases from two weeks old seedling to four weeks old seedling and then decreased as transplanting age increased to eight weeks old. The highest yield was obtained at four weeks of age (3.85) while the least was at eight weeks of age (2.53) and differed significantly. Bhuer *et al.* (1990) equally reported that early planting of rice gave higher yields and gradual decline in the grain in delayed transplanting. The reason was because the rice that were planted early had more time for its growth and development as well had more time for assimiliate translocation that led to increase in yield.On the other hand, plant spacing recorded non-significant effect (P>0.05) on the paddy yield. The highest yield was recorded at 30cm x 30cm plant spacing (3.56) while the least yield was at 40 cm x 40 cm spacing (2.61). Transplantlng age x plant spacing interaction was non-significant (P>0.05) on grain yield. The highest yield (t/ha) was obtained at four weeks of age and 30cm x 30cm (4.50) while the least yield was at eight weeks old seedling and a plant spacing of 40 cm x 40 cm (2.56).

Table 10: Effect of transplanting ages and plant spacing, interaction of transplanting ages x plant spacing on paddy yield (t ha[1]).

Treatments	plant spacing (cm)			
	20x20	30x30	40x40	Means
Transplanting age				
Two week,s old plant	3.18	3.68	2.43	3.10
Four weeks old plant	4.00	4.50	3.05	3.85
Six weeks old plant	2.75	3.59	2 .41	2.92
Eight weeks old plant	2.56	2.47	2.56	2.53
Means	3.12	3.56	2.61	

F-LSD (P=0.05),Transplanting Age =1.52, Plant Spacing=ns, Transplanting age x planting spacing =ns

4. Conclusion

In this experiment, the results clearly indicated that growth and yield performance of lowland rice was affected by transplanting age and plant spacing .This result showed that four weeks old plant with 30cm x 30cm demonstrated the highest paddy yield and can be recommended for rice production in the study area.

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