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REGULAR ARTICLE

Influence of tillage, seeding method and plant density on the performance of NERICA L-42 rice in the inland valley of rainforest/savanna agroecology

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ABSTRACT

Two field trials were conducted at Abeokuta and Ibadan, Nigeria with the aim of investigating the performance of rice NERICA L-42 as influenced by tillage (minimum and conventional), seeding method (direct seeded and transplanting) and plant density (0.15 × 0.15 m, 0.20 × 0.20 m and 0.25 × 0.25 m) of two seedlings per stand. Trials were in split-split plot arrangement in a randomised complete block design and replicated three times. Directly seeded rice had higher growth and faster development than transplanted rice at both locations. Minimum tillage and direct seeding at 888,888 plants ha^{-1} is recommended for this type of African environment.

Key Words: *agronomic performance; dry matter; transplanting; dry dibble.*

INTRODUCTION

Rice consumption is increasing in most parts of sub-Sahara Africa (SSA). The implication is the disruption in demand and supply of rice (West Africa Rice Development Association, 1997). The short fall has been met by importation (Daramola 2005), production intensification (Sakurai 2006) or cultivation of newly opened lands.

Rice is produced in different agroecologies in West Africa (Nwanze et al. 2006), the most financially viable being lowland rice with comparatively higher yield than rice from other agroecologies (Bernier et al., 2008). The method of rice establishment in lowland is transplanting under conventional tillage practise (wet cultivation). Conventional tillage practise by resource-challenged farmers is characterised by intensive, non-motorised pulverisation (several footwork) of soil following ploughing into slurry. This practise alters soil physical properties and water balance (Fuentes et al. 2009, Vogeler et al. 2009). It causes formation of tillage pan and disrupts rooting system of the succeeding crop. Direct seeding provides alternative cultural practise in lowland rice production. It fosters a reduction in production cost, increase in water conservation (Dawe 2005) and efficient water use, earlier flowering, and short cropping duration (Farooq et al. 2011). Despite the inherent drawbacks in direct seeding, an integrated approach with other cultural practises could prove to be a veritable tool in rice management.

One of such management approaches is the selection of appropriate plant density. The lower performance of directly seeded rice than transplanted could be compensated for through increased plant density. The choice of plant density is a function of planting method and time, availability of nutrient and moisture, weed interference, plant character, growth duration, and soil fertility (Shirtliffe and Johnston 2002). Closer spacing increases number of tillers per unit area, which could lead to inter-plant competition for available resources (water and light). Patel (1999) and Muhammadian et al. (2011) claimed that in most tropical regions the optimum spacing of rice in a decreasing order is 0.20 × 0.20 > 0.20 × 0.15 > 0.20 × 0.10 m. NERICA® L-42 is a lowland rice cultivar developed by AfricaRice. This rice cultivar is early maturing with maturity range of 90 to 100 days. NERICA (New Rice for Africa) rice is a product of interspecific hybridisation between IR 64 (*Oryza sativa*) and TOG 5681 (*Oryza glaberrima*) (Ndjiondjop et al. 2008). It had been reported that NERICA rice compared to the local lowland varieties is more tolerant of a negative effect of biotic and abiotic stress prevalence in most African countries (Kamara et al. 2011). Understanding the underlying mechanism involved in the performance of NERICA L-42 under intensive cultivation in the inland valley of rainforest savanna ecology would assist in the sustainable production of lowland rice.

There are few empirical evidences on the performance of NERICA L-42 as influenced by tillage practises, seeding method and plant density in the inland valley under intensive cropping system. This research aimed to study growth and yield responses of NERICA L-42 to tillage practises, seeding method and varying row spacing in the inland valley of rainforest/savanna agroecology.

MATERIALS AND METHODS

CHARACTERISATION OF LOCATION AND EXPERIMENTAL SITE

Two field trials were carried out at two locations in Nigeria; rainfed inland valley of the FUNAAB, Abeokuta (Latitude 7°15′N, Longitude 3°25 ′E; altitude 76 m a.s.l.), and paddy F 14 at the research farm of the Africa Rice Centre, Ibadan station (Latitude 7°30 ′N, Longitude 3°54′E), International Institute of Tropical Agriculture (IITA), Oyo road, Ibadan, Oyo–State. Rainfall distribution during the cropping season in 2011 ranged from 349.5 mm in July to – 0 in December at Abeokuta. The mean temperature ranged between 29.2°C (March and April) to– 24.5°C (July). During the cropping season at Ibadan, monthly rainfall ranged between 314.9 mm (August) to–absence of precipitation (December). The mean temperature range at Ibadan during the period ranged between 28.8°C to–24.5°C in March and August, 2011 respectively.

The textural class of the soil on the experimental site was determined using the USDA textural triangle. Soil particle size distribution was determined using the hydrometer method (Bouyoucos, 1962). The pH was determined (in 1: 1 soil: water) using a pH meter (glass electrode) (McLean, 1982). The organic content of the samples was analysed with the wet–oxidation method of Walkey-Black modified by Allison (1965) while total nitrogen with the modified micro Kjeldahl digestion technique (Jackson1962). Available phosphorus was analysed using Bray-1 (Bray and Kurtz 1945) and determined colometrically using the method of Murphy and Riley (1962). Exchangeable bases were extracted with Normal Ammonium acetate (1N NH4 OA) buffered at pH 7. Na^+, K^+ in the extract was determined by flame photometry while Ca^{2+} and Mg^{2+} was determined using Atomic Absorption Spectrophotometer (AAS). Total acidity was analyzed using KCl as the extracting medium, and the (H^+ + Al) was determined. Cation exchange capacity (CEC) was determined by the summation of total exchange bases (TEB) and total acidity (TA). Results of pre-planting soil analysis in Abeokuta indicated that the pH of the soil was close to neutral (6.75), soil organic matter was 33.1 g kg^{-1}, with 0.90 g kg^{-1} (total nitrogen) and 10.69 ppm (available phosphorus). The textural class of soil in Abeokuta was sandy loamy. Pre-planting soil pH at Ibadan was neutral (6.85). It consisted of 49.1 g kg^{-1} of organic matter, 0.60 g kg^{-1} total nitrogen and 4.49 ppm of available phosphorus. The textual class was sandy clay loamy. Lowland rice succeeded soybean at both location in the sequence.

EXPERIMENTAL TREATMENTS AND DESIGN

NERICA® L-42 was planted in inland valley, in Abeokuta and Ibadan simultaneously in 2011 cropping season. The main plot of the trial was 33.5 × 26.5 m and consisted of tillage practices (minimum and conventional). The sub-plot size measured 13.5 × 13 m and consisted of seeding methods (direct seeded and transplanting); the sub-sub plot was 5 × 4 m (20 m^2) and consisted of spacing (0.15 × 0.15 m, 0.20 × 0.20 m and 0.25 × 0.25 m, constituting 888,888, 500,000 and 320, 000 plants ha^{-1}, respectively at two seedlings per stand). The design for the field trials was randomised complete block design in split–split plot arrangement with three replicates. The gross plot size was 5 × 4 m (20 m^2). Minimum tillage was achieved by mechanical displacement of the soil with the use of the hand hoe; similar operation was used for conventional tillage, but with increased intensity of soil displacement that was achieved by pulverising the soil with feet and hand until it was transformed into slurry. Residue of preceding crop (soybean) was chopped after harvest (2.96 – 6.79 kg $plot^{-1}$ in Ibadan and 3.02 – 6.35 kg $plot^{-1}$ in Abeokuta) into about 0.10 m length and incorporated into soil for decomposition and mineralisation before planting NERICA L-42 rice cultivar.

CULTURAL OPERATIONS

Soybean [*Glycine max* (L). Merrill] crop of different varieties (TGx 1448-2E and TGx 1740-2F) preceded the establishment of lowland rice on the same field at both locations. The temporal interval between incorporation of soybean residue and lowland rice establishment was 17 days (Abeokuta) and 18 days (Ibadan). Lowland rice trials were established in 1 June, (Abeokuta) and 7 June, 2011 (Ibadan) (early wet seasons) for direct seeded. A dry bed nursery was established near the field for transplanted seedlings on the date direct seeded plants were established. The size of the bed was 1 × 5 m. The top soil was softened and watered. Rice seeds (transplanted rice seedling) were sown in the nursery on the date of seeding the dry direct seeded rice on the field and watered regularly for 3 weeks after which they were transplanted on 22 June and 28 June 2011 at Abeokuta and Ibadan, respectively. For the direct seeding, three to four seeds were sown and thinned to two seedlings per stand two weeks after sowing, while two of three weeks old seedlings were transplanted for the transplanted treatment.

Weeds were managed chemically with the usage of pre-emergence and post-emergence herbicides. Riceforce® with oxadiazon as active ingredient at 0.25 kg ha^{-1} was applied on the day of sowing at the rate of 3 kg a.i. per hectare, while OrizoPlus® (360 g of propanil and 200 g of 2, 4-D acid a.i. $litre^{-1}$), was applied at the average recommended rate of 10 kg a.i. per hectare at 18 days after transplanting (DAT). Weeds and off-type rice varieties were removed by post-emergence hand-weeding.

SAMPLING AND DATA COLLECTION

Pre-planting physico-chemical properties of the soil of the experimental site were evaluated. Thirty randomly taken soil samples were collected from a depth of 0-0.20 m and air-dried for analyses. Non-destructive parameters (leaf area, leaf area index, plant height and numbers of tillers per hill) were determined from ten randomly chosen rice plants per plot four weeks after planting. Destructive parameters were periodically evaluated from rice plants from some rows outside the net row except the border rows.

Agronomic parameters were taken at different growth stages except for the yield components and grain yield, which were assessed after harvest. For the direct seeding method, these corresponded to 49 days after planting (DAP), 77 DAP and 105 DAP for vegetative, reproductive and maturity growth stages respectively. For the transplanted rice this was 28 DAT, 56 DAT and 84 DAT relating to vegetative, reproductive and maturity stages respectively. Vegetative growth (emergence count, stand count, plant height, number of tillers per hill, leaf area, leaf area index and dry matter accumulation) was recorded. Days-to-50% flowering and days-to-95-% physiological maturities were determined. Yield components (number of panicle per square metre, panicle length, panicle weight, grains per panicle and 1000 grain weight) and grain yield were determined. One-square-metre quadrant was used 2 days before harvesting to evaluate number of panicles per square metre. Leaf area was determined as described by Gomez, (1972), at mid tillering phase, 50 % flowering and at harvest in which the leaf area of the main culms (i.e. length × breadth) was multiplied the by number of tillers per hill and by a factor of 0.67. Leaf area index was calculated by dividing leaf area per hill by area supporting the plants in a hill. Total above dry matter was established from sampled hills, oven dried at 70°C to a constant weight at mid-tillering, 50 % flowering and maturity.

STATISTICAL ANALYSIS

Data collected were subjected to the analysis of variance (ANOVA), using a mixed model. It consisted of fixed effects (tillage practise, seedling method and spacing) and random effects (according to the blocking structure of the split-plot design). Significant effects were separated using least significant difference (LSD). All variables were tested for the violation of ANOVA assumption prior to analysis by means of graphical analysis of residuals. Discreet data collected were transformed using square root and the transformed data were used for statistical test. The statistical package used was GENSTAT 12th Edition.

RESULTS AND DISCUSSION

VEGETATIVE GROWTH RESPONSES OF NERICA L-42 RICE

Tillage practises had no significant effect ($P > 0.05$) on the vegetative growth of NERICA L-42 evaluated in both locations (Tables 1 and 2). Martínez et al., (2008) reported that the effect of a tillage method is directly related to crop, soil type and prevailing climatic conditions. Rice is a shallow rooted crop; hence, the availability of moisture remains a limiting growth factor in most rice growing environments. Conventional tillage for lowland rice production is therefore conducted to ensure optimum moisture retention and availability, reduce nutrient loss (Singh et al., 2001) and suppress weed growth. Similarity in soil fertility status, textural trait and rainfall distribution at both locations (Ibadan and Abeokuta) could have predisposed NERICA L-42 to a similar response at different tillage practises. Other authors had reported conflicting results of the effect of puddling on lowland rice performance. In Sharma and De Datta, (1985) studies lowland rice yield increased with puddling, while Utomo et al., (1985) showed a reduced growth of lowland rice. These inconsistencies could have supported the observation earlier made by (Martínez et al., 2008). The non-significant effect of tillage practises could also be explained by the physico-chemical and biological effect of puddling in lowland ecology. Osunbitan et al. (2005) reported that tillage affected soil bulk density, infiltration and water retention capacity. Depending on the intensity of this operation, puddling could increase soil compaction and bulk density (Mousavi et al., 2009), resulting in reduced percolation and infiltration of soil moisture (McDonald et al., 2006). This operation in the lowland ecology aims to ensure water conservation. However, it predisposes the soil to anoxic condition that could negatively affect soil microbial activities, root growth and function. This condition could have explained low available N in both locations despite high soil organic matter, since decomposition of available biomass could be reduced. Another effect could be the prevalence of reduction reaction in the soil with reduced redox potential of soil (Ponnamperuma, 1978). The implication could be the prevalence of iron toxicity and other nutritional disorder (Sahrawat, 2005) or immobilisation of nutrients through reduction of decomposition reaction, as a result of anaerobic environmental soil condition. These negative consequences of anaerobic condition were substantiated in this trial, but the possibility of their occurrence could have had a negative impact on plants at both locations, with different intensity of tillage practises.

In Abeokuta, direct seeding method produced plants with significantly higher leaf area, leaf area index, number of tillers and above ground dry weight at all growth stages than transplanted rice, except at a reproductive stage, when there was no significant effect of the seeding method on the aboveground dry matter. Conversely, transplanted seedling of NERICA L-41 rice grew significantly ($P < 0.05$) taller plants compared to direct seeded. There was no significant effect of seeding methods on the plant height at maturity. A similar trend was observed in Ibadan. This observation is in contrast with earlier studies that indicated that direct seeded lowland rice was more susceptible to lodging due to its taller architecture (Farooq et al., 2011). Increased assimilatory surface observed in direct seeded lowland rice could predispose it towards interception of radiant energy for photosynthesis as reflected in its higher shoot dry matter accumulation in this trial. A similar observation was made by Wiangsamut et al., (2006) on rice in Philippines, where it was observed that direct-seeded rice had higher crop growth rate, assimilatory surface, and dry matter than transplanted rice. The increased assimilatory surface of directed seeded lowland rice could also be attributed to higher number of tillers per hill. However, earlier studies reported that ideotype of lowland rice favoured for direct seeding should possess fewer tillers, with lower panicle weight, thick root and culms (Won et al., 1998). The canopy architecture observed in this trial might have compromised the reproductive growth of NERICA L-42 rice.

In Abeokuta, increasing plant density resulted in a significant ($P < 0.05$) increase in hill count and leaf area index at all stages of growth. Leaf area at the vegetative stage of growth displayed a curvilinear response with increasing plant density. The increase in leaf area could have been explained by the significantly high ($P < 0.05$) hill count observed with increasing plant densities at both locations. However, this could not translate to higher grain yield through higher photosynthetic capacity, since presumably higher LAI has a direct positive relationship with the amount of light intercepted by crops (Tardieu, 2014). However, a significant ($P < 0.05$) depression was observed in the number of tillers with increasing plant density at vegetative growth stage and aboveground dry matter accumulation at all growth stages (Table 1). Similar pattern was also observed in Ibadan (Table 2). The lower number of tillers observed at both locations with increasing plant densities could be explained by the increased competition for available resources (light, water and nutrients) or the phenological phase at which it was observed, since the maximum number of tillers was formed when the crop attained the maximum growth. This was also reflected on the amount of dry matter formed and stover weight at both locations. Ahmadikhah et al., (2010) observed that increased plant density per unit area could predispose the plants to competition for available resources. However, Habib et al., (2013) observed a converse pattern when rice was grown under temperate condition with increasing plant density per unit area, where there was an increased number of effective tillers, grain and straw yield. Variability in crop response to plant density was indicated by Ahmadikhah et al., (2010) to be due to plant characteristics, soil fertility and moisture level, climatic condition, planting pattern and prevalence of weed.

Table 1. Effect of tillage, seeding method and spacing on the growth of NERICA® L-42 at Abeokuta

Treatments	EC (%)	Hill Count	Plant Height (cm)			Leaf Area (cm^2)			Leaf Area Index			Number of tillers per hill			Aboveground Dry weight (g)		
			Veg	Repr	Mat	Veg	Repr	Mat	Veg	Repr	Mat	Veg	Repr	Mat	Veg	Repr	Mat
Tillage (T)																	
Minimum	45.99	517.8	44.49	49.89	89.7	367	905	1083	1.00	2.56	3.01	16	25	30	3.77	6.61	11.22
Conventional	45.79	522.4	46.96	52.50	87.0	373	1036	1028	1.04	2.96	2.92	16	26	31	3.63	7.51	11.41
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Seeding Method (M)																	
Dry Dibble	91.78	503.8	38.73	45.56	86.6	405	1054	1186	1.10	2.99	3.28	20	30	35	4.03	7.64	12.74
Transplanted	-	536.5	52.72	56.83	90.2	335	887	924	0.94	2.55	2.64	13	21	27	3.38	6.48	9.89
LSD (0.05)	-	13.94	6.25	5.44	ns	62.3	40.3	184.9	0.15	0.20	0.64	2.37	2.42	2.80	0.24	ns	1.24
Spacing (cm) (S)																	
15 × 15	47.07	804.7	45.30	50.82	86.3	325	956	1008	1.44	4.25	4.48	14	24	30	3.48	6.31	10.22
20 × 20	45.72	454.6	45.00	50.54	90.6	404	1037	1052	1.01	2.59	2.63	17	27	32	3.61	7.43	11.47
25 × 25	44.89	301.2	46.87	52.23	88.2	381	919	1106	0.61	1.47	1.77	17	25	32	4.02	7.43	12.25
LSD (0.05)	ns	18.54	ns	ns	ns	57.6	ns	ns	0.17	0.39	0.46	1.60	ns	ns	0.31	0.62	1.16
Interactions																	
T × M	ns	ns	ns	ns	ns	ns	*	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
T × S	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
M × S	ns	ns	*	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	*	ns
T × M × S	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*	ns

EC was determined on dry dibbled plots only at 2 WAS

Abbreviations: EC – Emergence count, cm – centimetre(s), cm^2 – square centimetre(s), g – gramme(s), Veg. – vegetative stage, Repr. – Reproductive stage, Mat. – Maturity stage, ns – not significant, LSD - Least significant differences of means (5 % level), T – Tillage, S - Spacing, M - Seeding method, * - significant at 5 % level.

Table 2. Effect of tillage, seeding method and spacing on the growth NERICA® L-42 at Ibadan.

Treatments	EC (%)	Hill Count	Plant Height (cm)			Leaf Area (cm^2)			Leaf Area Index			Number of tillers per hill			Aboveground Dry weight (g)		
			Veg.	Repr.	Mat.	Veg.	Repr.	Mat.	Veg.	Repr.	Mat.	Veg.	Repr.	Mat.	Veg.	Repr.	Mat.
Tillage (T)																	
Minimum	46.15	522.4	45.11	50.57	90.2	346	945	1095	0.95	2.67	2.96	15	24	30	3.81	6.66	13.17
Conventional	46.69	522.6	46.49	51.88	87.3	349	984	969	1.02	2.74	2.71	15	24	29	3.47	6.63	13.14
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
Seeding Method (M)																	
Dry Dibble	92.84	512.1	37.70	44.04	88.3	371	1042	1130	1.05	2.87	3.05	19	28	33	4.00	7.07	13.78
Transplanted	-	533.0	53.90	58.41	89.2	325	887	933	0.91	2.54	2.62	12	20	27	3.28	6.23	12.54
LSD (0.05)	-	17.16	7.33	5.99	ns	ns	ns	ns	ns	0.27	0.43	2.46	4.88	4.6	0.37	0.65	0.77
Spacing (cm) (S)																	
15 × 15	47.17	811.8	46.84	52.10	87.0	342	914	915	1.52	4.06	4.07	13	22	28	3.47	5.98	12.31
20 × 20	46.35	453.8	44.63	50.42	91.0	342	987	1054	0.86	2.47	2.64	16	26	31	3.62	6.49	12.90
25 × 25	45.74	301.9	45.92	51.15	88.2	359	993	1126	0.57	1.59	1.80	16	25	31	3.83	7.48	14.27
LSD (0.05)	ns	21.17	ns	ns	ns	ns	ns	ns	0.20	0.45	0.44	2.26	ns	ns	ns	0.31	0.57
Interactions																	
T × M	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
T × S	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
M × S	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	*
T × M × S	ns	ns	ns	ns	ns	*	ns	ns	*	ns	ns	ns	ns	ns	ns	*	ns

EC was determined on dry dibbled plots only at 2 WAS

Abbreviations: EC – Emergence count, cm – centimetre(s), cm^2 – square centimetre(s), g – gramme(s), Veg. – vegetative stage, Repr. – Reproductive stage, Mat. – Maturity stage, ns – not significant, LSD - Least significant differences of means (5 % level), T – Tillage, S - Spacing, M - Seeding method, * - significant at 5 % level.

DEVELOPMENT RESPONSE OF LOWLAND RICE

At both locations, none of the treatments had any significant effect on the development of NERICA L-42, except for the seeding method. Transplanted seedling of NERICA L-42 had significantly longer duration for all the developmental parameters examined at both locations (Table 3). Lower number of days to 50 % flowering observed when NERICA L-42 rice was directly seeded was also reported by Gill et al. (2011) and was explained to be due to reduced transplanting shock and early establishment (Kotera et al. 2004). This trait was linked to drought tolerance in direct seeded lowland rice (Farooq et al. 2009). In this trial such a trait did not confer on direct seeded lowland rice a comparative advantage over transplanted, since they were both established under similar rainfall distribution pattern.

Table 3. Effect of tillage, seeding method and spacing on the development NERICA® L-42 at both locations.

Treatments	Abeokuta		Ibadan	
	Days to 50 % Flowering	Days to 95 % Maturity	Days to 50 % Flowering	Days to 95 % Maturity
Tillage (T)				
Minimum	68	95	69	95
Conventional	70	95	69	95
LSD (0.05)	ns	ns	ns	ns
Seeding Method (M)				
Dry Dibble	64	90	64	90
Transplanted	74	100	74	100
LSD (0.05)	1.94	2.48	1.35	1.35
Spacing (cm) (S)				
15 × 15	70	96	70	96
20 × 20	68	94	68	94
25 × 25	69	95	69	95
LSD (0.05)	ns	ns	ns	ns
Interactions				
T × M	ns	ns	ns	ns
T × S	ns	ns	ns	ns
M × S	ns	ns	ns	ns
T × M × S	ns	ns	ns	ns

Abbreviations: ns – not significant, LSD - Least significant differences of means (5% level), cm – centimetre(s), T – Tillage, S - Spacing, M - Seeding method.

GRAIN YIELD AND YIELD COMPONENTS RESPONSE

At both locations, tillage practises and seeding methods had no significant effect on yield components and grain yield of NERICA L-42 (Table 4 and 5). At Abeokuta, there was no significant effect of plant density on yield components and grain yield investigated except for stover weight, which decreased under increasing plant density. At Ibadan, increasing lowland rice population densities led to a significant increase in the number of panicles/m2 and 1000 grain weight. This could be indicative of the presence of more effective tillers at Ibadan than Abeokuta, because the total rainfall was higher in the former than the later, with comparatively similar distributions. Ibadan had also more exchangeable cations than Abeokuta. However, the non-significant effect of spacing on the other yield components examined could have explained its non-significant effect on grain yield. Conversely, a significant depression in stover weight with increasing lowland rice population density was also observed at Ibadan. This could have suggested the partitioning of assimilates for the reproductive growth at the expense of the vegetative growth as evidenced in the effect of increasing plant density on earlier enumerated yield components of NERICA L-42 at Ibadan.

Table 4. Effect of tillage, seeding method and spacing on the reproductive growth of NERICA® L-42 at Abeokuta.

Treatments	Panicle weight (g)	Panicle length (cm)	Number of Panicle/m²	Number of grains/panicle	1000 seed weight (g)	Harvest Index (%)	Grain Yield (t ha-1)	Stover weight (t ha-1)
Tillage (T)								
Minimum	18.81	25.66	138	135	24.97	42.55	3.03	6.00
Conventional	21.44	26.57	139	128	25.54	44.78	3.05	5.96
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns
Seeding Method (M)								
Dry Dibble	19.62	25.50	138	136	25.67	43.74	3.04	5.94
Transplanted	20.63	26.73	139	127	24.84	43.59	3.04	6.01
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns
Spacing (cm) (S)								
15 × 15	19.87	26.03	143	130	24.75	42.49	3.01	5.41
20 × 20	19.81	25.88	136	136	25.51	42.25	3.07	6.00
25 × 25	20.70	26.43	137	129	25.50	46.27	3.05	6.52
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	0.45
Interactions								
T × M	ns	ns	ns	ns	ns	ns	ns	ns
T × S	ns	ns	ns	ns	ns	ns	ns	ns
M × S	*	ns	*	ns	ns	ns	ns	ns
T × M × S	*	ns	ns	ns	ns	ns	ns	ns

Abbreviations: g – gramme(s), cm – centimetre(s), % - percent, t ha-1 – tonnes per hectare, ns – not significant, LSD - Least significant differences of means (5 % level), T – Tillage, S - Spacing, M - Seeding method, * - significant at 5 % level.

Table 5. Effect of tillage, seeding method and spacing on the reproductive growth NERICA® L-42 at Ibadan.

Treatments	Panicle weight (g)	Panicle length (cm)	Number of Panicle/m²	Number of grains/panicle	1000 seed weight (g)	Harvest Index (%)	Grain Yield (t ha-1)	Stover weight (t ha-1)
Tillage (T)								
Minimum	15.61	23.66	141	123	25.76	43.0	2. 9	6.30
Conventional	15.31	25.03	138	143	26.53	49.0	3.18	6.58
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns
Seeding Method (M)								
Dry Dibble	15.01	23.62	139	133	25.98	45.2	3.06	6.53
Transplanted	15.91	25.07	140	133	26.31	46.8	3.01	6.35
LSD (0.05)	ns	ns	ns	ns	ns	ns	ns	ns
Spacing (cm) (S)								
15 × 15	14.55	24.88	161.4	133.0	27.79	45.0	2.75	6.00
20 × 20	15.72	23.56	128.3	136.4	25.56	45.1	3.12	6.37
25 × 25	16.12	24.60	129.0	130.1	25.09	48.0	3.24	6.96
LSD (0.05)	ns	ns	17.08	ns	1.99	ns	ns	0.40
Interactions								
T ×M	ns	ns	ns	ns	ns	ns	ns	ns
T ×S	ns	ns	ns	ns	ns	ns	ns	ns
M ×S	ns	**	ns	*	ns	ns	ns	ns
T ×M ×S	ns	ns	ns	ns	ns	ns	ns	ns

Abbreviations: g – gramme(s), cm – centimetre(s), m² – square metre (s), % - percent, t ha-1 – tonnes per hectare, ns – not significant, LSD - Least significant differences of means (5 % level), T – Tillage, S - Spacing, M - Seeding method, * - significant at 5 % level, ** - significant at 1 % level.

Conclusion

The non-significant differences of tillage practises on plant characters, yield and its component in the inland valley of rainforest/savanna agroecology suggest that minimum tillage could be used because it is cost-effective, an important argument for resource-challenged farmers. The same can be concluded about the seeding method, since it is more cost-effective than transplanting and the plants matured earlier. Increasing plant density per unit area in this agroecology could be feasible because it led to higher numbers of panicles per m^2 and 1000 seed weight at Ibadan, where higher total rainfall and ECEC were observed. The efficacy of increasing plant density on the yield components at Ibadan could have suggested that this practise is attainable in other agroecologies where other growth factors are non-limiting.

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