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Effect of Planting Date, Spacing and Seeding Methods on Disease Development and Yield Components of Rice (*Oryza sativa* L.) in Southeastern Nigeria

Christian Chukwunenye Iwuagwu[1], Charles Ikechukwu Umechuruba[2] and Andrew Chukwuma Nwogbaga[3]

1. Department of Crop Science and Horticulture, Nnamdi Azikiwe University, PMB 5025, Awka, Anambra State, Nigeria

2. Evangel University, PMB 129, Abakaliki, Ebonyi State, Nigeria

3. Department of Crop Production and Landscape Management, Ebonyi State University, PMB 053, Abakaliki, Nigeria

Abstract: To investigate the effect of planting date, spacing and seeding methods on disease development and yield components of rice, a factorial experiment in randomized complete block design (RCBD) with four replications was conducted during 2011 planting season at Izzi Local Government Area (LGA) of Ebonyi State, Nigeria. This experiment was carried out with four levels of planting dates (early June, late June, early July and late July), three levels of spacing (15, 20 and 25 cm) and two levels of seeding method (direct seeding and seedling transplanting). The studied traits included plant height (PH), number of tillers (NT), leaf area (LA), root length (RL), panicle length (PL), 1,000 seed weight (SW), disease incidence and severity. The result showed that all the factors had significant effect on the parameters measured. Sowing in early July had the highest LA of 65.38 cm^2, PH of 122.00 cm, RL of 29.04 cm and TN of 10.54, and the second largest PL of 25.08 cm and SW of 25.12 g. Also sowing in early July had the highest disease severity of 3.21, followed by 3.14 which occurred in late July, while the least 2.17 occurred in early June. The direct seeding method had the highest disease incidence of 70.83%, followed by plant spacing of 15 cm × 15 cm which had the disease incidence of 69.72%, while sowing in early June had the least disease incidence of 57.50%. In conclusion, planting of rice in Southeastern Nigeria should be done in early July, as the yield components were significantly better than in other dates though with the highest disease severity.

Key words: Disease development, planting dates, spacing, planting methods, rice, Southeastern Nigeria, yield components.

1. Introduction

Rice (*Oryza sativa* L.) is the world's most important staple food crop. In Asia, it is the main item of diet of 3.5 billion people. Demand for rice in Nigeria is, however, growing faster than that for any other staple with consumption broadening across all socio-economic classes. Substitution of rice for coarse grains and traditional roots and tubers has fuelled growth in demand at annual rate of 5.6% between 1961 and 1992 [1]. The Food and Agricultural Organization (FAO) had in 2003 projected growth in rice consumption for Nigeria beyond year 2000 to remain as high as 4.5% per annum [1]. Nigeria have been identified to consume about 5.4 million metric tons of rice annually (valued at $9.2 billion at current prices), while local production amounts to 2.3 million metric tons per year and the remaining 3.1 million metric tons is imported, making Nigeria the second largest importer of rice in the world.

In Southeastern Nigeria, rice is normally sown at the beginning of May and transplanted during the first week of June. Transplanting is a rational method which gives high and stable yield, but at the same time, it is more laborious and expensive job. Nowadays, farmers are switching towards some other method, like direct seeding of rice to minimize these expenses and difficulty. The exact sowing date for direct seeding of rice also play a vital role in improving its growth and increasing yield [2]. Sowing time of the rice crop is important for three major reasons. Firstly,

Corresponding author: Christian Chukwunenye Iwuagwu, Ph.D., research field: plant pathology.

it ensures that vegetative growth occurs during the period of satisfactory temperatures and high level of solar radiation. Secondly, the optimum sowing time for each cultivated crop ensures that the cold sensitive stage occur when the minimum right temperatures are the warmest. Thirdly, sowing on the appropriate date guarantees that grain filling occurs when there is enough moisture in the atmosphere. Sowing date also has direct impact on the rate of establishment of rice seedling. Awan et al. [3] investigated the effect of planting date on grain yield and some agronomic characteristics of early seeding (June 15th and June 30th) and late seeding (July 15th and July 30th), and indicated that planting date affected the performance of these traits significantly.

There are different planting methods, but the most common one is seedling transplanting (ST) and direct seeding (DS). Transplanting of rice seedling in the traditional way is a laborious, time consuming and drudgery. But direct sowing of rice may be prone to moisture stress in dry areas or in irrigated rice production areas. The planting methods have an impact on the growth and yield, besides cost of cultivation and labour requirement. The choice of planting methods may depend on the availability of man power and technology, especially in developed countries where labour is very limited [4]. Besides its reduction in seeding rate which save money for seed, transplanting provides less competition for growth resources, such as sunlight moisture and nutrients, and enables easy crop management, like weeding and herbicides as well as pesticides application [5]. As a result, vigorous plants are produced, thus improving production of the crop. On one hand, direct seeding has good stand establishment, higher tillering, sometime higher grain yield, stable growth and reduces transplanting shock, but on the other hand, there is weed problem in direct seeding.

Optimum plant density is one of the most important factors for obtaining higher yield. It reduces the cost of seeds in rice and this also influences other agronomic components, such as leaf area, tillering, plant height and disease incidence and severity.

Therefore, the objective of this experiment was to investigate the effect of planting date, spacing and seeding methods on disease development and yield components of rice.

2. Materials and Methods

Experiment was conducted in a lowland location in 2011 at rice farm sited Izzi Local Government Area (LGA) of Ebonyi State. The 1zzi LGA of Ebonyi State lies between latitude 6°34′60″ N and 8°3′0″ E with average temperature of 27 °C, relative humidity of above 75% and annual rainfall of 1,800-2,000 mm. The soil is ultisol.

The experiment structure was a 4 × 3 × 2 factorial laid out in randomized complete block design (RCBD) with four replications. The treatments included: four levels of planting dates—early June (EJ), late June (LJ), early July (EJY) and late July (LJY), where EJ was June 15th, LJ was June 30th, EJY was July 15th and LJY was July 30th; three levels of planting spaces (15, 20 and 25 cm); two levels of seeding methods—DS and ST. The effective block size was 12 m × 8 m giving 96 m^2. The total plot size with paths was 12 m × 11 m giving 132 m^2. One lowland variety Faro 44 very susceptible to major fungi diseases in the area was used.

The site for the lowland rice was cleared and the vegetations were gathered together out of the farm. The soil was manually turned upside down with the use of hoes. The flat was marked out. Each flat measured 2 m × 2 m and space between each bed was 0.5 m, while inter block space was 1 m each.

The seeds were planted according to the specified dates. The first planting was done on EJ (June 15th), followed by LJ (June 30th). Four rice seeds were planted per stand. The planting date, planting space and seeding method were randomized within each block.

NPK fertilizer at dose of 400 kg/ha was applied at the rate of 75:30:30 NPK/ha at five weeks after sowing. The weed control was done by the use of herbicide. The herbicide was applied before planting. Hand weeding was also done as the need arose. Clearing of paths round the experimental farm was done as when necessary. The farms were fenced round with Nylon netting to prevent rodent attack. The farms were visited to inspect the performances of the plants twice weekly and collect necessary data for analysis.

Data collected from the crop included: plant height, number of tillers, leaf area, root length, panicle length, 1,000 seed weight, yield, disease incidence and severity. The percentage disease incidence of rice plants was determined, as suggested by Snedechor and Cochran [5], by the following Eq. (1):

$$\text{Disease incidence (\%)} = \frac{\text{number of diseased plants}}{\text{total number of plants sampled}} \times 100 \quad (1)$$

The diseased severity was assessed by observing diseased plants in a given unit and assigning severity score to each observation. A 5-point score [6] was adopted, where 1 = 1%-20% of plants infected; 2 = 21%-39% of plants infected; 3 = 40%-50% of plants infected; 4 = 51%-69% of plants infected; 5 = 70% of plants infected.

Data collected were subjected to ANOVA using SAS software package.

3. Results

3.1 Effects of Sowing Spaces on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Ebonyi State

Table 1 shows that there was a significant difference in the effect of planting spaces on leaf area, and root length.

The planting space of 15 cm had the highest root length (29.34 cm), which was significantly higher than the rest, followed by 28.16 cm produced by 25 cm planting distance, while the least was 27.47 cm in 20 cm distance.

For panicle length, 20 cm planting distance produced the highest panicle length (25.19 cm), followed by 25.13 cm in 25 cm planting distance, while the least was 24.94 cm in 15 cm distance.

There was significant ($P < 0.05$) difference of spacing on leaf area of rice plants. The largest leaf area (64.72 cm^2) was produced in 20 cm, which was significantly different from that in 15 cm (58.28 cm^2), but not significantly different from that produced in 25 cm (60.94 cm^2).

There was no significant difference in the effect of spacing on plant height and number of tillers. The highest plant height (120.69 cm) produced in 15 cm, not different with the rest, and the most number of tillers were observed in 20 cm (9.94), also not different with the rest (Table 1).

There was also no significant difference in the effect of spacing on 1,000 seed weight and yield of rice plants. The largest 1,000 seed weight (25.88 g) was produced by 25 cm distance, followed by 24.94 g in 15 cm distance, while the least was 24.69 g produced in 20 cm distance (Table 1). The largest yield (4,505 g) was produced by 15 cm spacing, followed by 4,489 g in 20 cm spacing, while the least 4,321 g was produced in 25 cm spacing.

The highest disease incidence percentage (69.72%)

Table 1 Effect of sowing spaces on yield, yield components, disease incidence and severity of rice plants in Ebonyi State.

Sowing spaces	Parameters									
	PH (cm)	TN	RL (cm)	PL (cm)	LA (cm^2)	SW (g)	DI (%)	DS	Yield per year (g)	Yield per ha (ton/ha)
15 cm	120.69	9.66	29.34	24.94	58.28	24.94	69.72	2.88	4,505	11.26
20 cm	120.59	9.94	27.47	25.19	64.72	24.69	64.97	2.75	4,489	11.22
25 cm	120.53	9.66	28.16	25.13	60.94	25.88	60.28	2.55	4,321	10.80
$LSD_{0.05}$	NS	NS	0.88	0.46	4.72	NS	3.70	0.27	NS	0.69

PH: plant height; TN: tillers number; RL: root length; PL: panicle length; LA: leaf area; SW: 1,000 seed weight; DI: disease incidence; DS: disease severity; NS: not significant.

was produce by 15 cm spacing, followed by 64.97% in 20 cm spacing and 60.28% in 25 cm spacing (Table 1). There was no significant difference on the effect of spacing on disease severity. The highest disease score (2.88) was produced by 15 cm spacing, followed by 2.75 in 20 cm spacing and 2.55 produced by 25 cm spacing.

3.2 Effects of Sowing Periods on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Ebonyi State

Table 2 shows that sowing periods had significant effect ($P < 0.05$) on some agronomic traits of rice plants. There was a significant difference between sowing period and plant height, where the highest plant height (122.00 cm) occurred in EJY, followed by 120.71 cm in LJY, while the least (119.75 cm) occurred in LJ planting. Only plant height in EJY was statistically different from that in EJ and LJ, but not that in LJY.

Tillers number differed significantly. The highest number of tillers (10.54) occurred in EJY, followed by 9.88 in EJ, and they were not statistically different from each other (Table 2). The longest root length (29.04 cm) occurred in EJY, which significantly higher than 27.92 cm in LJ, while other planting dates did not differ (Table 2). Table 2 also shows that panicle lengths did not differ, but the highest panicle length (25.38 cm) occurred in EJ, followed by 25.08 cm in EJY. The least (24.88 cm) was experienced in LJY.

Leaf area significantly ($P < 0.05$) differed. The largest leaf area (65.38 cm^2) occurred in EJY, followed by 61.04 cm^2 in LJY, while the least (58.17 cm^2) was in EJ (Table 2).

There was no significant effect on 1,000 seed weight, but the largest seed weight (26.25 g) was experienced in LJY, followed by 25.12 g in EJY. The least seed weight (24.54 g) occurred in EJ (Table 2). There was a significant effect on yield. The highest yield (4,977 kg) was experienced in EJY, followed by 4,509 kg in LJY, while the least (4,020 kg) was in EJ, which was statistically different from that in EJY and LJY (Table 2).

Table 2 shows that there was a high significant effect of sowing periods on disease incidence, with the highest disease incidence of 72.62% which occurred in EJY, followed by 70.08% in LJY, while the least of 57.50% occurred in EJ. There was also a high significant effect on disease severity, where the highest disease severity (3.21) occurred in EJY, followed by 3.14 in LJY, while the least (2.17) occurred in EJ (Table 2).

Table 2 Effects of sowing periods on yield, yield components, disease incidence and severity of rice plants in Ebonyi State.

Sowing periods	Parameters									
	PH (cm)	TN	RL (cm)	PL (cm)	LA (cm^2)	SW (g)	DI (%)	DS	Yield per year (g)	Yield per ha (ton/ha)
EJ	119.96	9.88	28.12	25.38	58.17	24.54	57.50	2.17	4,020	10.05
LJ	119.75	9.25	27.92	25.00	60.67	24.75	59.75	2.38	4,248	10.62
EJY	122.00	10.54	29.04	25.08	65.38	25.12	72.62	3.21	4,977	12.44
LJY	120.71	9.33	28.21	24.88	61.04	26.25	70.08	3.14	4,509	11.27
$LSD_{0.05}$	1.36	0.93	1.02	NS	5.45	NS	4.27	0.31	318.4	0.80

Table 3 Effects of sowing methods on yield, yield components, disease incidence and severity of rice plants in Ebonyi State.

Sowing method	Parameters									
	PH (cm)	TN	RL (cm)	PL (cm)	LA (cm^2)	SW (g)	DI (%)	DS	Yield per year (g)	Yield per ha (ton/ha)
DS	119.33	8.58	28.17	24.65	60.52	24.67	70.83	3.21	4,061	10.5
ST	121.88	10.92	28.48	25.52	62.10	25.67	59.15	2.24	4,816	12.05
$LSD_{0.05}$	0.96	0.66	NS	NS	NS	NS	3.02	0.22	225.2	0.56

3.3 Effects of Sowing Methods on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Ebonyi State

Table 3 shows that there was a significant ($P < 0.05$) difference of the effect of sowing methods on plant height. The ST method had better plant height. The same trend repeated in tiller number, disease incidence, disease severity and yield. There was no significant effect on root length, panicle length, leaf area and 1,000 seed weight.

3.4 Interaction of Sowing Methods, Sowing Periods and Sowing Spaces on Yield, Yield Components, Disease Incidence and Severity of Rice in Ebonyi State

Table 4 shows that there was a significant effect ($P < 0.05$) on plant height, where the highest plant height (124.75 cm) occurred in ST × EJY × 15 cm and ST × EJY × 20 cm, followed by (122.25 cm) in ST × LJY × 15 cm, while the least plant height in (117.50 cm) occurred in DS × EJ × 25 cm. It was observed that ST method produced better plant height compared to DS method.

There was a significant effect on tiller number ($P < 0.05$), where the highest tiller number (12.75) occurred in ST × EJ × 15 cm, followed by 12.50 in ST × EJY × 20 cm, while the least 7.25 occurred in DS × EJ × 15 cm. The same trend was repeated in tiller number, i.e., ST method produced better tiller number (Table 4). There was a significant effect ($P < 0.05$) on root length with the longest root (32.25 cm) which

Table 4 Interaction of sowing methods, sowing periods and sowing spaces on yield, yield components, disease incidence and severity of rice in Ebonyi State.

Treatments			Parameters									
Sowing method	Sowing period	Sowing space (cm)	PH (cm)	TN	RL (cm)	PL (cm)	LA (cm^2)	SW (g)	DI (%)	DS	Yield per year (g)	Yield per ha (ton/ha)
DS	EJ	15	117.75	7.25	29.50	25.00	48.25	24.00	72.25	2.75	4,267	10.67
		20	120.00	9.50	27.75	25.00	60.75	24.50	58.50	3.00	3,362	8.40
		25	117.50	8.75	28.00	24.75	66.75	24.75	58.75	2.75	3,682	9.20
	LJ	15	117.75	7.75	29.75	23.75	54.50	25.00	73.00	2.75	3,779	9.45
		20	119.75	9.00	26.75	24.25	67.75	25.00	63.50	2.75	4,726	11.81
		25	119.75	8.00	27.75	25.25	64.75	25.00	61.75	3.25	4,554	11.39
	EJY	15	119.25	9.00	28.00	24.25	53.50	25.75	82.00	4.00	3,938	9.85
		20	120.00	9.25	27.50	25.25	67.00	24.25	76.50	3.50	4,003	10.01
		25	121.00	8.50	29.25	24.50	67.75	24.50	72.50	3.50	4,448	11.12
	LJY	15	120.25	8.00	27.25	24.00	51.50	24.75	80.00	3.50	3,969	9.92
		20	118.75	8.50	28.25	24.25	56.25	24.25	75.25	3.75	4,040	10.10
		25	120.25	9.50	28.25	24.50	67.50	24.25	76.00	3.00	3,964	9.91
ST	EJ	15	121.75	12.75	29.25	25.75	60.50	25.25	49.50	2.00	4,438	11.10
		20	121.00	10.00	27.50	25.75	59.25	24.25	54.50	1.25	4,577	11.44
		25	121.75	11.00	26.75	26.00	53.50	24.50	51.50	1.25	3,795	9.49
	LJ	15	121.75	10.25	30.50	26.00	59.25	24.50	55.50	1.75	4,157	10.39
		20	119.25	10.25	25.75	25.25	61.75	24.75	52.25	2.00	4,354	10.89
		25	120.25	10.25	27.50	25.50	55.50	24.25	52.50	1.75	3,918	9.79
	EJY	15	124.75	12.25	32.25	26.00	76.25	25.75	72.25	3.00	6,155	15.39
		20	124.75	12.50	27.75	25.50	68.00	25.75	70.50	3.00	5,888	14.72
		25	122.25	11.75	29.50	25.00	59.75	24.75	62.00	2.25	5,427	13.35
	LJY	15	122.25	10.00	28.75	24.75	62.00	24.50	73.25	3.25	5,338	13.35
		20	121.25	10.50	28.50	25.25	77.00	24.75	68.75	2.75	4,966	12.42
		25	121.50	9.50	28.25	25.50	52.00	25.00	47.25	2.61	4,777	11.94
$LSD_{0.05}$			3.34	2.29	2.49	1.30	13.35	NS	10.47	0.76	780.0	2.00

occurred in ST × EJY × 15 cm, followed by 30.50 cm in ST × LJ × 15 cm, while the least (25.75 cm) occurred in ST × LJ × 20 cm. Also ST method produced better root length than DS (Table 4).

There was a significant effect on panicle length, where the longest panicle length (26.00 cm) occurred in ST × EJ × 25 cm, ST × LJ × 15 cm and S × EJY × 15 cm, followed by 25.75 cm in ST × EJ × 15 cm and ST × EJ × 20 cm, while the least (23.75 cm) occurred in DS × LJ × 15 cm. There was a high significant effect ($P < 0.05$) on leaf area with the highest leaf area of (77.00 cm^2) which occurred in ST × LJY × 20 cm, followed by 76.25 cm^2 in ST × EJY × 15 cm, while the least (48.25 cm^2) occurred in DS × EJ × 15 cm (Table 4).

There was no significant effect ($P < 0.05$) on 1,000 seed weight, but the largest 1,000 seed weight (25.75 g) occurred in DS × EJY × 15 cm, ST × EJY × 15 cm and ST × EJY × 20 cm, followed by 25.25 g in ST × EJ × 15 cm, while the least (24.00 g) occurred in ST × EJ × 15 cm.

Table 4 also shows that there was high significant effect on disease incidence, where the highest disease incidence (82%) occurred in DS × EJY × 15 cm, followed by 80.00% in DS × LJY × 15 cm, while the least (47.25%) occurred in ST × LJY × 25 cm. Generally, the DS produced the highest disease incidence than ST method. Also the plant spacing of 15 cm × 15 cm produced higher disease incidence than the other spacing. Rice plants planted in EJY had the highest disease incidence compared to others.

There was also high significant interaction effect on disease severity. The highest disease score (4.00) occurred in DS × EJY × 15 cm, followed by 3.75 in DS × LJY × 20 cm. The least disease severity score (1.25) occurred in ST × EJ × 20 cm and ST × EJ × 25 cm. Also the same trend repeated where DS produced higher disease severity compared to ST (Table 4).

There was a significant interaction effect ($P < 0.05$) on yield, where the highest yield (6,155 kg) was produced in ST × EJY × 15 cm, followed by 5,888 kg on ST × EJY × 20 cm, while the least (3,362 kg) occurred in DS × EJ × 20 cm.

3.5 Interaction of Sowing Methods and Sowing Periods on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Ebonyi State

Table 5 shows that there was a significant interaction effect ($P < 0.05$) of sowing method and sowing period on most of the parameters studied.

There was significant interaction effect on plant height, where the highest plant height (121.6 cm) was experienced in ST × EJY, followed by 121.50 cm in ST × EJ, while the least (118.42 cm) occurred in DS × EJ. Generally, ST method had better plant height than DS (Table 5).

Table 5 Effects of sowing methods and sowing periods on yield, yield components, disease incidence and severity of rice plants in Ebonyi State.

Sowing methods	Sowing periods	Parameters									
		PH (cm)	TN	RL (cm)	PL (cm)	LA (cm^2)	SW (g)	DI (%)	DS	Yield per year (g)	Yield per ha (ton/ha)
DS	EJ	118.42	8.50	28.42	24.92	58.58	24.42	63.17	2.83	4,770	9.43
	LJ	119.08	8.25	28.08	24.42	62.33	25.00	66.08	2.92	4,353	10.88
	EJY	120.08	8.92	28.25	24.67	62.75	24.83	77.00	3.67	4,130	10.32
	LJY	120.67	8.67	27.92	25.50	56.42	24.42	77.08	3.42	3,991	9.98
ST	EJ	121.50	11.25	27.83	25.83	57.75	24.67	51.83	1.50	4,270	10.68
	LJ	120.00	10.25	27.75	25.58	59.00	24.50	53.42	1.83	5,823	10.36
	EJY	121.62	12.17	29.83	25.50	68.00	25.42	68.25	2.75	4,143	14.56
	LJY	120.88	10.00	28.50	25.17	63.67	28.08	63.08	2.87	5,027	12.57
$LSD_{0.05}$		1.93	1.32	1.44	0.75	7.71	3.32	6.04	0.44	450.4	1.13

There was significant interaction effect on tiller number, where the highest tiller number (12.17) occurred in ST × EJY, followed by 11.25 in ST × EJ, while the least (8.25) was experienced in DS × LJ. ST had significantly higher number of tiller than DS (Table 5).

There was also significant interaction effect ($P < 0.05$) on root length, where the longest root length of 29.83 cm was experienced in ST × EJY, followed by 28.50 cm in ST × LJY, while the least (27.75 cm) occurred in ST × LJ (Table 5). There was a significant interactions effect on panicle length, where the longest panicle length of 25.83 cm occurred in ST × EJ, followed by 25.58 cm in ST × LJ, while the least was 24.42 cm experienced in DS × LJ (Table 5). There was significant effect on leaf area, where the largest lead area of 68.00 cm^2 occurred in ST × EJY, followed by 63.67 cm^2 in ST × LJY, while the least (56.42 cm^2) occurred in DS × LJY .

There was also a significant interaction effect on 1,000 seed weight, where the largest seed weight of 28.08 g was produced by ST × LJY, followed by 25.42 g in ST × EJY, while the least 24.42 g occurred in both DS × EJ and DS × LJY. Other seed weights were not statistically different from each other (Table 5).

Table 5 also shows that there was a very high significant interaction effect on disease incidence. The highest disease incidence (77.08%) occurred in DS × LJY, followed by 77.00% in DS × EJY, while the least 51.83% occurred in ST × EJ. Generally, as in other interaction effects, DS produced higher disease incidence than ST. There was a significant interaction effect ($P < 0.05$) on disease severity, where the highest disease severity of 3.67 occurred in DS × EJY, followed by 3.42 in DS × LJY, while the least 1.50 was found in ST × EJ (Table 5).

There was a significant interaction effect on yield with the highest yield of 5,823kg occurred in ST × LJ, followed by 5,027 kg in ST × LJY, while the least 3,991 kg occurred in DS × LJY (Table 5).

3.6 Interaction of Sowing Methods and Sowing Spaces on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Ebonyi State

Table 6 shows that there was significant interaction effects ($P < 0.05$) of sowing methods by sowing space. There was a significant interaction effect on plant height, where the highest plant height (122.62 cm) was experienced in ST × 15 cm, followed by 121.56 cm in ST × 20 cm, while the least 118.75 cm occurred in DS × 15 cm. Generally ST method produced better plant heights than DS. The similar plant height (119.62 cm) was produced in DS × 20 cm and DS × 25 cm.

There was a significant effect ($P < 0.05$) on number of tillers, where the highest tiller number (11.31) was experienced in ST × 15 cm, followed by 10.81 in ST × 20 cm, while the least 8.00 was experienced in DS × 15 cm (Table 6).

There was a significant interaction effect on root length, where the longest root of 30.06 cm occurred in ST × 15 cm, followed by 28.62 cm in DS × 15 cm, while the least 27.38 cm occurred in ST × 20 cm. There was a significant interaction effect on panicle length. The longest panicle length (25.63 cm) occurred in ST × 15 cm, followed by 25.50 cm in ST × 25 cm, while the least 24.25 cm was obtained in DS × 15 cm. Generally, ST had better panicle length than DS (Table 6).

There was a very high significant interaction effect ($P < 0.05$) on leaf area with the largest leaf area (66.69 cm^2) obtained in DS × 25 cm, followed by 66.50 cm^2 which occurred in ST × 20 cm, while the least leaf area (51.94 cm^2) was experienced in DS × 15 cm (Table 6).

Table 6 shows that there was no significant interaction effect on seed weight.

There was a very high significant interaction effect on disease incidence, where the highest disease incidence (76.81%) occurred in DS × 15 cm, followed by 68.44% in DS × 20 cm, while the least 53.31% in

Table 6 Effect of sowing methods and sowing spaces on yield, yield components, disease incidence and severity of rice plants in Ebonyi State.

Sowing methods	Sowing spaces	Parameters									
		PH (cm)	TN	RL (cm)	PL (cm)	LA (cm^2)	SW (g)	DI (%)	DS	Yield per year (g)	Yield per ha (ton/ha)
DS	15	118.75	8.00	28.62	24.25	51.94	24.88	76.81	3.25	3,988	9.97
	20	119.62	9.06	27.56	24.94	62.94	24.50	68.44	3.25	4,033	10.80
	25	119.62	8.69	28.31	25.00	66.69	24.62	67.25	3.125	4,162	10.41
ST	15	122.62	11.31	30.06	25.63	64.62	25.00	62.62	2.50	5,022	12.55
	20	121.56	10.81	27.38	25.44	66.50	24.88	61.50	2.25	4,946	12.37
	25	121.44	10.63	28.00	25.50	55.19	27.12	53.31	1.97	4,479	11.20
$LSD_{0.05}$		1.67	1.14	1.24	0.65	6.68	NS	5.23	0.38	390.0	0.98

Table 7 Effects of sowing spaces and sowing periods on yield, yield components, disease incidence and severity of rice plants in Ebonyi State.

Sowing spaces	Sowing periods	Parameters									
		PH (cm)	TN	RL (cm)	PL (cm)	LA (cm^2)	SW (g)	DI (%)	DS	Yield per year (g)	Yield per ha (ton/ha)
15 cm	EJ	119.75	10.00	29.38	25.38	54.38	24.62	60.87	2.38	4,352	10.88
	LJ	119.25	9.00	29.88	24.88	57.12	24.75	64.25	2.25	3,968	9.92
	EJY	122.00	10.62	30.12	25.13	64.88	25.75	77.12	3.50	5,047	12.62
	LJY	121.25	9.00	28.00	24.58	56.75	24.62	76.62	3.38	4,653	9.98
20 cm	EJ	120.50	9.75	27.62	25.38	60.00	24.38	56.50	2.13	3,969	9.92
	LJ	119.50	9.62	26.25	24.75	64.75	24.88	57.87	2.38	4,540	11.35
	EJY	122.38	10.88	27.62	25.38	67.50	25.00	73.50	3.25	4,945	12.36
	LJY	120.00	9.50	28.38	25.25	66.62	24.50	72.00	3.25	4,503	11.26
25 cm	EJ	119.62	9.88	27.38	25.38	60.12	24.62	55.12	2.00	3,738	9.35
	LJ	120.00	9.12	27.62	25.38	60.12	24.62	57.12	2.50	4,236	10.59
	EJY	121.62	10.12	29.38	24.75	63.75	24.62	67.25	2.88	4,938	12.34
	LJY	120.88	120.8	9.50	28.25	25.00	29.62	59.75	2.81	4,371	10.93
$LSD_{0.05}$		2.36	1.62	1.76	NS	NS	4.06	7.40	0.54	551.6	1.38

ST × 25 cm. Generally, DS produced higher disease incidence than ST (Table 6).

There was a significant interaction effect ($P < 0.05$) on disease severity, where the highest disease severity 3.25 was obtained in DS × 15 cm and DS × 20 cm, followed by 3.13 in DS × 25 cm, while the least 1.97 occurred in ST × 25 cm. Also as in disease incidence, DS produced higher disease severity compared to ST method (Table 6).

There was a significant interaction effect ($P < 0.05$) on yield, where the highest yield (5,022 kg) in ST × 15 cm, followed by 4,946 kg in ST × 20 cm, while the least 3,988 kg was experienced in DS × 15 cm. Generally, ST had a better yield than DS (Table 6).

3.7 Interaction of Sowing Spaces and Sowing Periods on Yield, Yield Components, Disease Incidence and Severity of Rice in Ebonyi State

Table 7 shows that there was a significant interaction effect of sowing space and sowing period on some traits of rice plants. There was significant effect on plant height, where the highest plant height (122.38 cm) occurred in 20 cm × EJY, followed by 122.00 cm in 15 cm × EJY, while the least 119.25 cm was experienced in 15 cm × LJ. There was a significant effect on number of tillers, where the highest number of tillers (10.88) was produced in 20 cm × EJY, followed by 10.62 in 15 cm × EJY, while the least 9.00 in 15 cm × LJ and 15 × LJY (Table 7). There was a significant interaction effect ($P < 0.05$) on root length, where the longest root length (30.12 cm) occurred in 15 cm × EJY, followed by 29.88 cm in 15 cm × EJ, while the least 26.25 cm was experienced in 20 cm× LJ (Table 7).

Table 7 also shows there was no significant interaction effect on panicle length and on leaf area.

There was a significant interaction effect ($P < 0.05$) on 1,000 seed weight, where the largest seed weight of 29.62 g was produced in 25 cm × LJY, followed by 25.75 g produced in 15 cm × EJY, while the least 24.38 g occurred in 20 cm × EJ (Table 7).

There was also a significant interaction on disease incidence, where the highest disease incidence of 77.12% occurred in 15 cm × EJY, followed by 76.62% produced in 15 cm × LJY, while the least 55.12% was obtained in 25 cm × EJ. Disease incidence was also high in EJY compared to other planting dates (Table 7).

There was a significant interaction effect ($P < 0.05$) on disease severity. The highest disease severity (3.50) occurred in 15 cm × EJY, followed by 3.38 in 15 cm × LJY, while the least 2.00 was produced in 25 cm × EJ. Also EJY had higher disease severity than other dates (Table 7).

From Table 7, it was clear that there was a significant interaction effect on yield, where the highest yield 5,041 kg was produced in 15 cm × EJY, followed by 4,945 kg in 20 cm × EJY, while the least 3,738 kg occurred in 25 cm × EJ. It was also observed that EJY had better yield than other planting date, as well as planting space of 15 cm × 15 cm produced a better yield than other spacing.

4. Discussion

4.1 Effect of Sowing Dates on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Southeastern Nigeria

The results showed that planting dates had significant effect (5%) on the yield, yield components, disease incidence and severity of rice plants in Southeastern Nigeria. This is because planting time of any field crop depends on the environmental conditions that are required for its growth and development. The result is similar to the report of Javaid et al. [7], who observed that yield of rice usually declines when planting is delayed beyond the optimum time. Awan et al. [3] also reported that all the agronomic traits studied with respect to planting dates indicated a significant effect. Mobasser et al. [4] also reported that rice plants require a particular temperature for its physiological activities, such as panicle initiation, flowering, panicle emergence from the flag leaf sheath and maturity, and these are very much influenced by the planting date. Rice seeding before the window of optimum date usually has slow germination, poor stand establishment and increased damage from soil borne seedling disease under cold conditions, as well as loss of seeds to birds [2]. Planting rice after the optimum dates can result in higher disease and insect incidence and tropical storm-related lodging [8, 9].

4.1.1 Effect of Planting Period on Tillers Number of Rice Plants in Southeastern Nigeria

The results showed that there was a significant effect (5%) of planting date on tillers number of rice plants. The highest tillers number (10.54) occurred in EJY, followed by 9.88 in EJ, while the least was 9.25 in LJ. This result corroborates with the report of Birhane [10] who observed that number of tillers/m^2 was influenced by various planting dates. According to his result, the maximum number of fertile tiller/m^2 (335) was observed when crop was sown on June 20th, while the crop sown on July 20th gave the minimum tillers/m^2 (200). Among the yield components, productive tillers are very important because the final yield is mainly a function of the number of panicle bearing tillers per unit area. The increase of fertile tiller/m^2 at June 20th sowing was attributed to favourable environmental conditions, which enabled the plant to improve its growth and development as compared to other sowing dates. His result was a little bit different from that in this study where the highest tillers number was obtained in EJY, while it occurred in mid June in his study. This could have been as a result of inherent potential of the crop and the environmental influence on this potential which determines how it is manifested and optimized [11].

4.1.2 Effect of Planting Period on Panicles Length of Rice Plants in Southeastern Nigeria

The results showed that there was no significant effect of planting period on panicle length, though the longest panicle length of 25.38 cm occurred in EJ, followed by 25.08 cm in EJY, while the least 24.88 cm was experienced in LJY. This is in consonance with the findings of Mobasser at al. [4], who reported that number of kernel per panicle is significantly affected by different sowing dates. According to them, seeding in June 20th produced the maximum number of kernels (984.90), while the minimum number of kernel per panicle (46.57) was produced by seeding in July 20th. They went further to say that the reason could be that late sowing shortened the growth period of the plant which led to reduced leaf area, length of panicle and number of kernel per panicle than early sowing. Number of filled grains per panicle was found in the decreasing trend from the seeding of June onward [12, 13]. Kernel per panicle which is a function of panicle length showed better response with early sowing [14].

4.1.3 Effect of Planting Periods on Leaf Area of Rice Plant in Southeastern Nigeria

There was a significant effect of planting periods on leaf area of rice plants in 2011 in Southeastern Nigeria, where the largest leaf area (65.38 cm^2) occurred in EJY, followed by 61.04 cm^2 in LJY, while the least (58.17 cm^2) occurred in EJ. This is in consonance with the report of Vandana et al. [15], who found that one important index that has effective impact on photosynthetic ability of rice plants is leaf area index. According to them, with delaying in planting, harvesting index would be decreased. This may be contrary in Nigeria, where early planting takes place in June, because this will lead to poor seedling growth and development as a result of delay of onset of rains experienced in most parts of the world especially in Nigeria. Therefore, farmers who dare plant in EJ which has been favourable in the past could realize that by this time the climatic condition which has hitherto been conducive for DS or ST might not be adequate because of delay in onset of the rains. In a way, planting rice in EJ, which is regarded in the past as early planting with its attendant higher yield, is no longer profitable as experienced in this study. The reason is obvious by the fact that instead of higher yield which is in correlation with the findings of many authors as stated above, yield decline was experienced in this study for early June.

4.1.4 Effect of Plating Periods on Seed Weight of Rice Plants in Southeastern Nigeria

The results showed that there was no significant effect of planting period on seed weight of rice in Southeastern Nigeria in 2011, where the largest seed weight (26.25 g) was obtained in LJY, followed by 25.12 g in EJY. The least seed weight (24.54 g) occurred in EJ. Thousand grain weight, an important yield determining component, is a genetic character least influenced by environment. Therefore, the result obtained in this study is in agreement with the findings of Awan et al. [3], who reported that all the traits studied with respect to planting date indicated significant effect with the exception of panicle grain number, panicle grain weight and 1,000 grain weight.

The result obtained in this study was in disagreement with Groth et al. [2] who reported that transplanting date had significant effect on plant height, total sterile spikelet per panicle, 1,000 grain weight, total tillers number, panicle per m^2, grain yield and harvest index.

Birhane [10] reported that exact sowing date for direct seeding of rice plays a vital role in improving its growth and increase yield. According to him, the sowing time of the rice crop is important for three major reasons. Firstly, it ensures that the vegetative growth occurs during a period of satisfactory temperature and level of solar radiation. Secondly, ensure that the rice crops escape the adverse conditions, such as minimum night temperature, when the rice plant is sensitive to cold. Thirdly, seeds sown on time guarantee that grain filling occurs when optimum temperatures are more likely, hence good grain quality is achieved. From the forgoing submissions, early planting of rice is adequate, but the challenge now is to identify the period that one could say this is early. This is because period that used to be early in the recent past may not be adequate now. In Nigeria, for instance, planting rice by EJ could be said to early, but recently by EJ, the rains has not fully established as to support seeding or transplanting of rice as in the time past. This could have been the major reason, why the highest 1,000g grain weight was obtained in July, while the least was obtained in June. The result obtained is in agreement with Vandana et al. [15]. According to them, transplanting date had not significant effect on 1,000 grain weight. Hassanein et al. [16] revealed that in case of 1,000 grain weight, the maximum weight was noticed for genotypes transplanted on June 1st, June 16th and July 1st also showed non-significant difference with regard to this parameter.

4.1.5 Effect of Planting Periods on Yield of Rice Plants in Southeastern Nigeria

The results showed a significant effect of planting date on yield of rice plants in Southeastern Nigerian in 2011. The highest yield (4,977 kg) was obtained in EJY, followed by 4,509 kg in LJY, while the least 4,020 kg occurred in EJ. This result is contrary to report of Awan et al. [3], who obtained the highest yield in June 15th planting date, followed by June 30th and July 30th, respectively while the least occurred in July 1st. The disagreement in the result of the present study and that of Awan et al. [3] could be attributed to the drastic change in weather conditions, which has resulted in late onset of rains in Nigeria and other parts of the world. Thus, the month of June, which used to be optimum for transplanting of rice, is no longer ideal because of delay in the onset of rain. That is to say that by June, the weather might not be very adequate for proper establishment of rice plants, especially the early stages with its attendant vulnerability to adverse temperature and moisture stress [10].

According to Ehsanullah et al. [17], late transplanting date in rice decreases grain yield. This is also in support of the report of Vandana et al. [15], who observed that with delaying in planting, harvesting index would be decreased. This now calls for a further research to establish the period that could be understood to be late in relation to transplanting or seeding rice in Southeastern Nigeria. This is because this study has success in establishing the ideal period to start planting rice, but has not shown when it could be considered as being late. Hassanein et al. [16] reported that sowing and transplanting rice at the optimum time is important for obtaining high paddy yield. Too early or too late transplanting causes yield reduction due to crop sterility and lower number of productive tillers [18].

Cantrell and Hettel [19] also reported that dry matter accumulation in leaves decreases in some cultivars of rice with late transplanting date.

4.1.6 Effect of Planting Periods on Disease Incidence of Rice Plants in Southeastern Nigeria

The planting dates showed significant effect on disease incidence, where the highest disease incidence (72.62%) occurred in EJY, followed by 70.08% in LJY, while the least 57.50% was obtained in EJ. This could have been as a result of high humidity at that period which favours fungi pathogens. This is in accordance with the report of Naklang et al. [8] and Laory et al. [9], who observed that planting rice after the optimum date can result in higher disease and insect incidence, tropical storm-related lodging and possible damage during heading and grain filling period resulting in low yield. The result of this research revealed that the highest rice yield for crop planted in EJY also has a challenge of high incidence of disease attack as a result of the high humid prevalence during that period. This is also in agreement with the report of Ahonsi at al. [20], who observed that planting date significantly affected disease incidence. They reported that rice sown with early rain was virtually free from disease, while those sown when the rain has fully established or at the peak were the most infected with fungi disease, such as false smut in Edo state of Nigeria.

4.2 Effect of Sowing Methods on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Southeastern Nigeria

The results showed that there was a significant effect of planting methods on yield, some yield components, disease incidence and severity of rice plants in southeastern Nigeria in 2011.

This is because in the modern era of rapid technological advancement in agriculture and consistent increase in population, poverty and food shortage, there is need to develop new methods and techniques of crop production not only to increase the productivity per unit area and time in order to meet the effective food and forage, but also to make effective utilization of agriculture input resources. Also, any plan to increase food production can not be a total success, until an appropriate production—orientated cropping system and production technology for each ecological zone is developed and properly implemented [21].

According to Mobasser et al. [4], there are different planting methods for rice crop production, but the most common ones are ST and DS, which were also investigated in this study. The result in this study showed a significant effect of planting method on plant height, where ST method gave higher plant height (121.88 cm) than DS (119.33 cm). This is because plant height is a yield component which is affected by genetic and crop management, growing condition, seeding age, vigour and nutrition [4]. Mobasser et al. [4] reported that the highest plant height (95.70 cm) in his experiment was produced by TS, while the shortest (77.80 cm) was under DS. This is in agreement with the result of this study, where the highest plant (121.88 cm) was obtained from ST method, while the least plant height (119.33 cm) was from DS. This might have been as a result that the plants had good growing condition under ST due to more appropriate spacing, which might have resulted in higher performance of the crop [4]. This result also agrees with International Rice Research Institute [6] which reported that transplanting enables the optimal spacing which can influence tillers, plant height and paddy yield over poor spacing inherent in DS method. Safdar et al. [11] also revealed that ST had significantly higher tiller count, greater number of panicle and higher yield than DS. The result also showed a significant effect of planting method on tiller count, where ST method had greater tiller count (10.92) than DS (8.58). This is in consonance with the reports of Yoshida [22], Moradpour et al. [23] and Mahmood et al. [24], who reported that ST significantly increased number of tillers/m^2 compared with DS. According to Mahmood et al. [24], the reason could have been as a result of higher performance of rice crop under ST due to the optimal spacing and growth.

The result also showed that there was a significant effect of planting method on diseases incidence and severity. DS method had disease incidence of 70.83% and severity of 3.21, which were significantly higher than 59.15% and 2.24, respectively, in ST method. This could have been as a result of poor spacing and high population density, which lead to dense canopy and the attendant high humidity suitable for fungi disease growth and development compared to appropriate spacing obtainable in ST method. This is in agreement with other researches [4, 6, 11, 25, 26], where it was reported that besides its reduction in seeding rate which save money for seed, ST provides less crop competition for growth resources, such as sunlight, moisture and nutrients, and enables easy crop management, like weeding and herbicide as well as pesticide applications. There was a significant effect of planting methods on yield, where ST method had significantly higher yield (4,816 kg) than DS (4,061 kg). This result is similar to the report of Mobasser et al. [4], who also observed that ST produced higher overall mean grain yield than DS. According to them, the difference between the yield obtained from DS and ST could be due to less competition for growth resources in ST and better air circulation which reduces the prevalence of insect pests and disease infestation. This is in disagreement to Safdar et al. [11], who reported that traditionally rice is transplanted, but consistent increase in labour cost in recent time calls for other planting methods. Also as a result of increased labour cost, ST system is gradually being replaced by DS in many developing countries [7, 20]. The result obtained in this study is also in disagreement with Vange and Obi [27], who reported that DS has good stand establishment, higher tillering and sometimes higher grain yield, and other advantages are stable growth, reduced transplanting shock, but there is weed problem.

4.3 Effect of Planting Space on Yield, Yield Components, Disease Incidence and Severity of Rice Plants in Southeastern Nigerian

The results showed a significant effect of planting space on some agronomic traits of rice plants in Southeastern Nigeria.

There was no significant effect of planting space on rice plant height. Although planting distance of 15 cm × 15 cm had the highest plant height (120.69 cm), followed by 120.59 cm which occurred in 20 cm × 20 cm, while the least 120.53 cm was observed in 25 cm × 25 cm, but they were statistically the same. The reasons could have been due to the closer ranges in the sowing spaces used in this experiment. This result is in disagreement with the report of Bashir et al. [28], who observed that there was a significant effect of row and inter-row spacing on most agronomic traits of rice in Northern Iran; total tillers number, fertile tillers number, panicle number/m^2, total spikelets per panicle and grain yield were significantly affected by different sowing spaces.

In this experiment, except tillers number and grain yield which were not significantly affected were contrary to the findings of Bashir et al. [28], all other parameters, which were significantly affected by spacing in their experiment, were different from the ones studied in this experiment.

The report of Safdar et al. [11] revealed that the highest tillers number, fertile tillers number were obtained in 30 cm × 30 cm planting space, while the greatest panicle number/m^2 and the highest grain yield were obtained in 15 cm × 15 cm planting space.

5. Conclusions

The results of the experiment showed that planting dates, spaces and methods have significant effects on disease incidence, severity and yield. EJY was found to be most appropriate in terms of yield, but to avoid high disease infestation, EJ was the best time. Planting distance of 15 cm × 15 cm was most adequate for higher yield. ST method, which had higher yield but with higher cost, should be improved by making machines for transplanting rice seedling available to farmers, so as to reduce labour cost. This implies that rice farmers in the area should be properly informed through adequate extension services about the appropriate planting method that demands less cost and labour, as well as most ideal spaces and time to plant their crops in order to avoid the periods of high disease infestation and to ensure proper harvest.

References

[1] Ezeji, J. 2009. *Supporting Nigerian Farmers Do Well.*

[2] Groth, D. E., and Lee, F. N. 2003. “Rice Diseases.” In *Rice: Origin, History, Technology and Production,* edited by Smith, C. W., and Dilday, R. H. Hoboken, NJ: John Wiley & Sons, 413-36.

[3] Awan, T. H., Ahmad, M., Asnraf, M. M., and Ali, I. 2011. "Effect of Different Transplanting Methods on Pady Yield and Its Components at Farmers Field in Rice Zone of Punjab." *J. Animal and Plant Sci.* 21 (3): 498-502.

[4] Mobasser, H. R., Tari, D. B., Vojdani, M., Abadi, R. S., and Eftekhari, A. 2007. "Effect of Seedling Age and Planting Space on Yield and Yield Components of Rice (Ned Variety)." *Asian J. Plant Sci.* 6 (2): 438-40

[5] Snedechor, G. W., and Cochran, W. G. 1994. "Statistical Methods." *Journal of Education and Behavioural Statistics* 19 (3): 304-7.

[6] International Rice Research Institute (IRRI). 2007. *Annual Report of the Director General, 2006-07.* Vol. 17. Los Baños, Philippines: IRRI.

[7] Javaid, T., Awan, I. U., Shah., B., Nadim, I. H., and Khan, M. A. 2012. "Effect of Planting Methods on the Growth and Yield of Coarse Rice." *J. Animal and Plant Sci.* 22 (2): 358-62.

[8] Naklang, K., Fukai, S., and Nathabuk, K. 1996. "Growth of Rice Cultivars by Direct Seeding and Transplanting under Upland and Lowland Conditions." *Field Crop Res.* 48 (2-3): 115-23.

[9] Laory, J. K., Dogbe, W., Boamah, P. O., and Asawini, J. 2012. "Evaluation of Planting Methods for Growth and Yield of 'Digang' Rice (*Oryza sativa* L.) under Upland Condition of Bakwu, Upper East Region, Ghana." *ARPN J. Agri. Biol. Sci.* 7 (10): 814-9.

[10] Birhane, A. 2013. "Effect of Planting Methods on Yield and Yield Components of Rice (*Oryza sativa* L.) Varieties in Tahtay Koraro Wereda, Northen Ethiopia." *Int. J. Technol. Enhance. Emerg. Eng. Res.* 1 (5): 1-5.

[11] Safdar, M. E., Ali, M., Muhammad, S., Sarwar, G., and Awan, T. H. 2008. "Effect of Transplanting Dates on Paddy Yield of Fine Grain Rice Genotypes." *Pak. J. Bot.* 40 (6): 2403-11.

[12] Noorbakhshian, S. J. 2003. "Effect of Seed Rate, Planting Date in Nursery and Transplanting Date on Yield and Yield Components of Rice (Koohrang Cultivar)." *Iranian J. Crop Sci.* 5 (4): 261-72.

[13] Hay, R. K. M., and Walker, J. A. 1989. *An Introduction to the Physiology of Crop Yield,* 1st ed.. Harlow, England: Longman Scientific & Technical, 167.

[14] Biswas, P. K., and Salokhe, V. M. 2001. "Effect of Planting Date, Intensity of Tiller Separation and Plant Density on the Yield of Transplanted Rice." *J. Agri. Sci.* 137 (3): 279-87.

[15] Vandana, J., Ains, G. S., and Mavi, H. S. 1994. "Effect of Different Dates of Transplanting on Biomass of Production and Its Partitioning in Various Parts of Rice Crop." *Indian J. Ecol.* 21 (1): 13-8.

[16] Hassanein, N. M., Abouzeid, M. A., Youssef, K. A., and Mahmoud, D. A. 2008. "Efficacy of Leaf Extracts of Neem (*Azadirachta indica*) and Chinaberry (*Melia azedirach*) against Early Blight and Wilt Diseases of Tomato." *Australian Journal of Basic and Applied Science* 2 (3): 763-72.

[17] Ehsanullah, A. N., Jabran, K., and Habib, T. 2007. "Comparisons of Different Planting Methods for Optimization of Plant Population of Fine Rice (*Oryza sativa* L.) in Punjab, Pakistan." *Pakistan J. Agri. Sci.* 44. (4): 597-9.

[18] Amed, O., Fawole, O. B., and Balogun, O. S. 2007. "Component Analysis for Seed Mycoflora in Four Cultivars of Cowpea (*Vigna unguiculata* (L.) Walp.)." *Centre Point* 14 (1-2): 71-7.

[19] Cantrell, R. P., and Hettel, G. P., eds. 2004. *New Challenges and Technological Opportunities for Rice-Based Production Systems for Food Security and Poverty Alleviation in Asia and Pacific.* Rome, Italy: FAO.

[20] Ahonsi, M. O., Adeoti, A. A., Erinle, I. D., Alegbejo, M. D., Singh, B. N., and Sy, A. A. 2000. "Effect of Variety and Sowing Data on False Smut Incidence in Upland Rice in Edo State, Nigeria." *Int. Rice Res. Notes* 25 (1): 14.

[21] Faghani, R., Mobasser, H. R., Dehpor, A. L., and Kochaksarai, S. T. 2011. "The Effect of Planting Date and Seedling Age on Yield and Yield Components or Rice (*Oryza sativa* L.) Varieties in North of Iran." *Afr. J. Agri. Res.* 6 (11): 2571-5.

[22] Yoshida, S. 1981. *Fundamentals of Rice Crop Science.* Los Banos, Laguna: International Rice Research Institute, 94-110.

[23] Moradpour, S., Koohi, R., Babael, M., and Khorshidi, M. G. 2013. "Effect of Planting Date and Planting Density on Rice Yield and Growth Analysis (Fajr Variety)." *Int. J. Agri. Crop Sci.* 5 (3): 267-72.

[24] Mahmood, N., Hussain, A., Akhtar, B., Ahmad, A. N., and Saleem, M. 1995. "Effect of Transplanting Date and Irrigation on Rice Paddy Yield." *Sci. Technol. Dev.* 14 (3): 49-52.

[25] Saikia, L., Chandra, K., and Mahanta, T. C. 1989. "Performance of Late Transplanting Rice in Asia." *International Rice Research News Letter* 14 (1): 21.

[26] Nazir, M. S. 1994. "Sugarcane." In *Crop Production,* edited by Basfur, E., and Bantel, R. Islamabad: National Book Foundation, 421-2.

[27] Vange, T., and Obi, I. U. 2005. "Effect of Planting Data on Some Agronomic Traits and Grain Yield of Upland Rice Varieties at Makurdi, Benue State Nigeria." *J. Sust. Develop. Agri. Environ.* 2 (1): 1-9.

[28] Bashir, M. U., Akbar, N., Asif, I., and Haroon, Z. 2010. "Effect of Different Sowing Dates on Yield and Yield Components of Direct Seeded Coarse Rice (*Oryza sativa* L.)." *Pak. J. Agri. Sci.* 47 (4): 361-5.