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Growth attributes and yield of rice *(Oryza Sativa.* L) as affected by weed control treatments, poultry manure and stand density.

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Abstract
Field trials were conducted in 2011 and 2012 wet seasons at Rigasa Farm Settlement in Kaduna (09^o 12'N; 08^o 39E') in the Northern Guinea Savanna ecological zone Nigeria. To evaluate performance of upland rice as affected by weed control treatments, poultry manure and stand density. The treatments consisted of three rates of five weed control treatments (0.6+0.4, 1.2+0.8, 1.8+1.2 Kg.a.i/ha spropanil+2.4-D, hoe weeding and weedy check) and poultry manure (0, 5 and 10t /ha) factorially combined in the main plot while there were three stand density (2, 4 and 6 plants per hill) in the sub-plot given a total of 45 treatments. The treatments were laid out in a split-plot design with three replications. Results revealed that application of 1.2+0.8Kg.a.i./ha of Orizoplus (propanil+ 2-4 D) produced significantly larger leaf area, high leaf area index, higher crop growth rate, relative growth rate, net assimilatory rate and grain yield of rice than the other rates but were comparable with the hoe weeded control. The application of 10t/ha of poultry manure gave significantly larger leaf area, high leaf area index, higher crop growth rate, relative growth rate, net assimilatory rate and grain yield of rice than the lowest rates and the control (0 and 5t/ha). The four plants per hill resulted in significant increase larger leaf area, high leaf area index, higher crop growth rate, relative growth rate, net assimilatory rate and grain yield of rice and higher yield of rice in both locations. The study showed that application of 10t/ha of manure, 1.2+0.8kg.a.i/ha of oriza plus and four plants per hill gave the best yield of rice.
Keywords*: Rice, poultry manure, herbicide, plant density and grain yield*

Introduction

Rice (Oryza saliva. L) is the third most widely grown cereal in the world after wheat (*Triticum aestivum* L) and maize (*Zea may*) and the single most important food for more than half of the world's population (F.A.O., 2013). Statistics showed that 672,015,587 million metric tonnes of milled rice was produced from 153,652,007 hectares of land worldwide in 2013 out of which Africa accounted for only 23.3million metric tonnes of milled rice. Nigeria is the second largest producer of rice in the continent after Egypt, with a total production of 4,833,000 million tonnes from 2,600,000 hectares of land in 2013 (F.O.A., 2014). Rice production in Nigeria is seriously constrained by many factors including weed infestation. The estimated losses due to weeds in West Africa range from33-75% in lowland and 70-100% in upland rice varieties (Akobundu, 1987). Weed interference in rice is known to reduce grain yield by affecting grains per panicle. In Nigeria the average yield reduction due to uncontrolled weed growth in rice ranged from 80-100% (Akobundu, 1987). Although, chemical weed control in upland rice is less developed in Tropical Africa and Latin America than in S.E. Asia, it however offers the most practical way of controlling weeds in the crop. The factor that has made chemical weed control more popular than manual and mechanical weeding is less drudgery that is associated with the chemical than cultural methods. Another factors limiting the production of rice is the nutrient requirement and the use of chemical fertilizers has been increased worldwide for cereal production (Abril *et al*., 2007) due to availability of inexpensive fertilizers (Graham and Vance, 2000). The continued use of chemical fertilizers causes health and environmental hazards such as ground and surface water pollution by nitrate leaching (Pimentel, 1996). So, reducing the amount of nitrogen fertilizers applied to the field without a nitrogen deficiency will be the main challenge in field management. One of the possible options to reduce the use of chemical fertilizer could be recycling of organic wastes. Poultry manure as the organic waste can be a valuable and inexpensive fertilizer and source of plant nutrients. Positive effects of organic waste on soil structure, aggregate stability and water-holding capacity were reported in several studies (Jedidi *et al*., 2004; Odlare *et al*., 2008; Shen and Shen 2001; Wells *et al*., 2000). A number of workers have reported that maintenance of a critical level of rice plant population in field was necessary to maximize grain yields. Faruk *et al*., (2009) reported that the highest grain yield of rice was recorded from two plants per hill and the lowest one was recorded from single plant per hill. In order to improve the productivity of rice using poultry manure which is less expensive and generally available and affordable to farmers and to assess the effectiveness of chemical weed control measure on rice under different plant density. This research is was carried to achieve the following objectives:-

i. To determine the best rate of poultry manure for optimum yield of upland rice.
ii. To determine the efficacy of oryzaplus to control weeds.
iii. To determine the best number of plants per hill that may give the best yield of paddy rice

Materials and Methods

Field trials were conducted during the wet seasons of 2011 and 2012 at the Research Farm of the Institute for Agricultural Research, Samaru (L 11^{o} 11'N; Long. 07^{o}38E' and 686m altitude)

The treatments consisted of three rates of poultry manure (0, 5 and 10t /ha) and five weed control treatments (0.6 + 0.4, 1.2 +0.8, 1.8 + 1.2 kg. a.i/ha of propanil and 2,4,D, hoe weeding and weedy check) factorially combined and assigned to the main plot while three stand density (2, 4 and 6 plants per hill) assigned in the sub-plot, given a total of 45 treatments. The treatments were laid out in a split-plot design with three replications. The net plot size was 3m by 4m (12m^2) and gross plot size was 4m by 4.5m (18m^2). The following parameters were taken:

Plant Height

The heights of five tagged plants were taken by measuring the plants from the basal ground level and to the base of flag leaf using metre ruler. This was taken at 9 and 12WAS.

Leaf Area Index (L A I):

This refers to the assimilatory surface per unit of ground area covered by the plant and was calculated using the formula given by Watson (1958).

$$\text{L A.I} = \frac{L \times B \times 0.07}{A}$$

Where: L = length of the leaf, B= breath of the leaf, K= 0.70 A= Area covered by the leaf. This was taken at 9 and 12WAS

Crop Growth Rate (CGR)

Crop growth rate is the dry matter accumulation of crop community per unit land area per unit time. This was measured as followed: four plants from discard plots were cut off carefully above the soil surface. The samples then were oven dried at 70 C to a constant weight and later the average dry matter production per plant was obtained at 9 and 12WAS. The dry weight increment per unit (CGR) was calculated using the following equation. (Watson, 1958).

$$\text{CGR} = \frac{W_2 - W_1}{t_2 - t_1} \quad (\text{g/m}^2\text{/wk})$$

Where W_1 and W_2 are dry weight in gram at times t_1 and t_2 in days respectively.

Relative Growth Rate (RGR): Relative growth rate is the cumulative dry matter increment per unit of time. This was calculated 9 and 12 WAS using the formular by (Fischer, 1921).

$$\text{RGR} = \frac{\log_e W_2 - \log_e W_1}{t_2 - t_1}$$

(g/g/wk) Where W_1 and W_2 are dry weight in gram at times t_1 and t_2 in days respectively

Net assimilation rate (NAR)

Net assimilation rate refers to photosynthetic efficiency of assimilatory surfaces.

This was computed using the formula suggested by Watson (1947). It was recorded at 9 and 12WAS.

$$\text{NAR} = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{\log_e A_2 - \log_e A_1}{A_2 - A_1} \quad (\text{g/cm}^2\text{/wk})$$

Where W_1 and W_2 are dry weight in gram at times t_1 and t_2 where corresponding leaf area was A_1 and A_2 respectively

Results and Discussion

Plant Height:

The effect of weed control treatments, poultry manure and stand density on the plant height of rice was significant. At 9 WAS, application of all rates of the herbicide gave statistically similar height of rice plants but were taller than those of the weedy check treatment. At 12 WAS however, it was the application of highest rate of the herbicide resulted in taller plants of rice than the lowest rates (0.6Kg + 0.4 Kg a.i./ha and 1.2Kg + 0.8 Kg a.i./ha) and the weedy check but was comparable to the HWC.

The highest rate (10t/ha) of poultry manure gave taller plants than the 5 and 0t/ha throughout the sampling periods. Stand density had no influence on the plant height of rice.

In 2012, at 12WAS all rates of the herbicide resulted in shorter plants of rice compared to hoe weeded control. The two rates (5 and10t/ha) of poultry manure gave taller plants than the control 0t/ha at 12WAS.Stand density had no significant effect on plant height of rice at 9 and 12WAS.

Leaf Area index.

The effect of weed control treatments, poultry manure and stand density on the leaf area index of rice was significant. At 9WAS, application of 0.6+0.4 and 1.8+1.2Kg .a.i./ha rates of the herbicide gave statistically similar leaf area index of rice plants while among the weed control treatment evaluated 1.2+0.8Kg.a.i./ha gave the highest value and the weedy check had the least. At 12WAS however, it was the application of highest rate of the herbicide resulted in larger leaf area index of rice than the other rates ((0.6 +0.4 and 1.2 +0.8kg.a.i./ha) and the weedy check but was comparable to the hoe weeded control. Similarly, at 3 and 6WAS, the highest rate (10t/ha) of poultry manure gave higher value of leaf area index than the lowest rate and control (5 and 0t/ha). However at 9WAS the two rates of manure had similar leaf area index. stand density had no influenced on the leaf area index of rice at 12WAS In 2012, at 12WAS, application of all rates of herbicide resulted in significant similar leaf area index of rice plant while hoe weeded control had the highest value and the weedy check had the least. At 9 and 12WAS, the highest rate (10t/ha) of poultry manure gave highest value than the 5 and 0t/ha while leaf area of rice was only influenced by stand density at 9 and 12WAS. At 9 WAS, 2 plants per hill gave higher leaf area index compared to the others two densities but at 12 WAS, 4 and 6 plants per hill gave similar high value of leaf area index while 2 plants per hill gave the lowest.

Crop growth rate: The effect of weed control treatments, poultry manure and stand density on the crop growth rate of rice was significant. At 9 and 12WAS however, it was the application of highest rate of the herbicide (1.8+1.2kg.a.i/ha)resulted in larger value of crop growth rate of rice than the others two rates ((0.6 +0.4 kg.a.i/ha and 1.2 +0.8 kg.a.i/ha). The highest rate (10t/ha) of poultry manure gave higher value of crop growth rate than the 5 and 0t/ha throughout the sampling period. In 2012, application of all rates of the herbicide gave statistically similar crop growth rate of rice but was significantly higher than that of the weedy check at 3WAS. However, at 9 and 12WAS, it was the application of highest rate of the herbicide that gave significantly higher crop growth rate than the lowest rate but was at par with the medium rate of 1.2+0.8Kg.a.i/ha at 12WAS. Application of poultry manure had significant effect only at 9WAS and 12WAS where the 10 and 5t/ha gave the high crop growth rate of rice than the control at 9WAS and 10t/ha gave the highest crop growth rate than 5 and 0t/ha at 12WAS.

At 9WAS stand density had significant effect on the crop growth rate in which 2 and 4 plants per hill had the highest value and six had the lowest (Table 2 The interaction between all treatments was not significant throughout the sampling periods in both locations and seasons.

Relative growth rate: The effect of weed control treatments, poultry manure and stand density on the relative growth rate of rice was significant. Application of all rates of the herbicide gave statistically similar relative growth rate of rice plants but were comparable to the hoe weeded control at 9WAS while the weedy check gave the least relative growth rate at 12WAS. There was no significant effect of poultry manure application on the relative growth rate except at 12WAS where application of two rates (5 and10t/ha) of poultry manure gave higher relative growth rate of rice than the control. Stand density had influenced on the relative growth rate of rice at all sampling periods. At 9 and 12WAS, planting at all densities hill gave similar relative growth rate of rice.

At 9WAS however, application highest rate resulted in higher relative growth rate of rice comparable to hoe weeded control and the weedy check had the least while at 12WAS, application of (1.2kg.a.i + 0.8kg.a.i/ha) treatments gave statistically lower relative growth rate of rice than the application of lowest rate highest 1.8+1.2 Kg.a.i/ha and hoe weeded control. At 9 and 12WAS stand density had significantly influenced relative growth rate of rice were 6 plants per hill had higher relative growth rate than planting at other two densities.

The interaction between all treatments was not significant throughout the sampling periods in both locations and seasons

Net Assimilation Rate: The effect of weed control treatments, poultry manure and stand density on the net assimilation rate of rice was significant.

Application of all rates of the herbicide gave statistically similar net assimilatory rate of rice plants but were comparable to the hoe weeded control at 9WAS while the weedy check gave the least net assimilatory rate at 12WAS. However there was no significant effect of poultry manure application on the net assimilatory rate except at 12WAS where application of highest rate (10t/ha) of poultry manure and the control treatment gave net assimilatory rate of rice than the application of 5t/ha of the manure. However, stand density had influenced on the net assimilatory rate of rice at all sampling periods. At 9 and 12WAS, planting at all densities hill gave similar net assimilatory rate of rice.

At 9WAS, application highest rate resulted in higher net assimilatory rate of rice comparable to hoe weeded control and the weedy check had the least. 12WAS, application of (1.2kg.a.i + 0.8kg.a.i/ha) treatments gave statistically lower net assimilatory rate of rice than the application of lowest rate highest 1.8+1.2 Kg.a.i/ha and hoe weeded control.

The highest rate (10t/ha) of poultry manure gave high net assimilatory rate of rice at all the sampling periods except at 12WAS where two rates of manure gave similar net assimilatory rate of rice.

At 9 and 12WAS stand density had significantly influenced net assimilatory rate of rice were 6 plants per hill had higher net assimilatory rate than planting at other two densities. The interaction between all treatments was not significant throughout the sampling periods in both locations and season.

Grain yield

In the both years and the average at Rigasa application of all rates of herbicide produced similar value of rice grain yield but the hoe weeded control gave the highest grain yield while the weedy check gave the lowest grain yield. In 2011 application of the lowest rate and control produced statistically similar grain yield of rice but the highest rate of manure (10t/ha) gave the highest grain yield while in 2012, application of two rates of manure 5 and 10t/ha gave similar grain yield of rice that is higher than the control (0t/ha). However at the combine, the highest rate of manure application produced the highest grain yield of rice than the lowest rate and the control 5 and 0t/ha. Stand density had significantly on the grain of rice. Two plants per hill had the highest value grain yield of rice in 2011 while four plants per hill had the highest in 2012 and the mean.

Table 1: The effect of weed control treatments, poultry manure and stand density on the crop growth rate and relative growth rate of rice at Samaru in 2011 and 2012

		PLANT HEIGHT				LEAF AREA INDEX OF RICE			
		2011		2012		2011		2012	
Treatment	**Rate**	**9WAS[1]**	**12WAS**	**9WAS**	**12WAS**	**9WAS**	**12WAS**	**9WAS**	**12WAS**
Weed Control(W)									
Propanil +2,4-D (Kg.a.i./ha)									
	0.6 + 0.4	81.6ab	92.0b	78.9ab	83.0c	0.57c	0.84b	0.62b	0.696b
	1.2 + 0.8	82.8ab	93.7b	78.4b	83.7c	0.66a	0.86b	0.65a	0.692b
	1.8 + 1.2	85.2ab	98.3a	79.4a	82.8c	0.63b	0.93a	0.62b	0.685b
Hoe weeded at 3 & 6WAS		85.6a	95.1ab	79.4a	85.3a	0.62b	0.92a	0.65a	0.770a
Weedy check		79.5b	81.1c	79.2a	79.8d	0.64b	0.81c	0.54c	0.592c
SE±		2.52	1.75	0.33	0.23	0.003	0.040	0.010	0.11
Poultry Manure(M) (t/ha)									
	0	76.9c	88.1b	78.6b	80.6	0.55b	0.82b	0.60b	0.67b
	5	83.2b	89.9b	79.6a	82.9	0.63a	0.86ab	0.61b	0.67b
	10	88.8a	99.1a	89.0a	83.4	0.64a	0.92a	0.63a	0.72a
SE±		1.15	1.36	0.26	0.19	0.004	0.003	0.02	0.14
Stand Density(P) (plant/hill)									
	2	81.1	92.2	78.6	82.6	0.63a	0.82	0.64a	0.61b
	4	84.1	90.9	78.4	82.9	0.61b	0.89	0.61b	0.73a
	6	81.6	93.0	79.6	83.4	0.61b	0.26	0.60c	0.72a
SE±		1.28	1.28	0.16	0.19	0.003	0.020	0.020	0.110
Interaction									
	P×M	NS	NS	NS	NS	NS	NS	NS	NS
	W XP	NS	NS	NS	NS	NS	NS	NS	NS
	Wx M	NS	NS	NS	NS	NS	NS	NS	NS
	Wx M x P	NS	NS	NS	NS	NS	NS	NS	NS

1=WAS: Week after sowing

2= Mean followed by the same letter within a column of each treatment group are not significantly different at P$\leq$ 0.05 using DMRT

3=.NS: No significant,

Table 2: The effect of weed control treatments, poultry manure and stand density on the crop growth rate and relative growth rate of rice at Samaru in 2011 and 2012

		CROP GROWTH RATE OF RICE							
		2011		2012		2011		2012	
Treatment	**Rate**	**9WAS**	**12WAS[1]**	**9WAS**	**12WAS**	**9WAS**	**12WAS**	**9WAS**	**12WAS**
Weed Control(W)									
Propanil +2,4-D(Kg.a.i/ha)									
	0.6 + 0.4	4.50b	10.55b	4.30b	5.40b	0.07ab	0.12a	0.063bc	0.119ab
	1.2 + 0.8	3.90c	9.72c	4.10bc	6.20a	0.06b	0.09bc	0.0671b	0.113b
	1.8 + 1.2	5.10a	12.60a	5.11a	5.99a	0.07ab	0.10b	0.072ab	0.127a
Hoe weeded at 3 & 6WAS		3.50d	9.40c	3.86c	5.83a	0.06b	0.10b	0.086a	0.128a
Weedy check		2.88dc	8.10d	0.542b	0.59c	0.08a	0.09c	0.049c	0.086c
SE±		0.01	0.16	0.140	0.170	0.04	0.004	0.005	0.001
Poultry Manure(M) (t/ha)									
	0	4.10b	10.33b	4.0b	9.07b	0.06	0.13a	0.061b	0.09b
	5	4.36ab	9.05c	4.40a	7.82c	0.07	0.04b	0.065b	0.12a
	10	4.60a	10.90a	4.40a	10.20a	0.07	0.13a	0.077a	0.12a
SE±		0.08	0.13	0.10	0.13	0.004	0.007	0.004	0.007
Stand Density(P) (plant/hill)									
	2	4.30	9.96b	4.35a	8.95	0.06b	0.11ab	0.058b	0.11ab
	4	4.40	10.71a	4.60a	8.91	0.07ab	0.11a	0.075b	0.10b
	6	4.40	9.61c	4.00b	9.21	0.08a	0.11b	0.076a	0.12a
SE±		0.09	0.16	0.090	0.110	0.004	0.005	0.004	0.005
Interaction									
	P×M	NS	NS	NS	NS	NS	NS	NS	NS
	W x P	NS	NS	NS	NS	NS	NS	NS	NS
	W x M	NS	NS	NS	NS	NS	NS	NS	NS
	W x M x P	NS	NS	NS	NS	NS	NS	NS	NS

RELATIVE GROWTH RATE

1=WAS: Week after sowing

2= Mean followed by the same letter within a column of each treatment group are not significantly different at P≤ 0.05 using DMRT

3=.NS: No significant,

Table 3: The effect of weed control treatments, poultry manure and stand density on the net assimilatory rate and grain yield of rice at Samaru in 2011 and 2012

		NET ASSIMILATORY RATE				**GRAIN YIELD OF RICE(Kg/ha)**		
		2011		**2012**				**Rigasa**
Treatment	**Rate**	**9WAS**	**12WAS[1]**	**9WAS**	**12WAS**	**2011**	**2012**	**12WAS**
Weed Control(W)								
Propanil +2,4-D(Kg.a.i/ha)								
	0.6 + 0.4	0.011a	0.021ab	0.014b	0.011b	2297b	1732b	1515b
	1.2 + 0.8	0.009b	0.018b	0.013bc	0.012a	2407b	1974b	2190b
	1.8 + 1.2	0.013a	0.022a	0.017a	0.012a	2751b	1808b	2280b
Hoe weeded at 3 & 6WAS		0.009b	0.017b	0.010c	0.010ab	4020a	3082a	3556a
Weedy check		0.008	0.016b	0.001d	0.001c	833c	175c	504c
SE±		0.015	0.012	0.005	0.001	36.7	51.7	46.0
Poultry Manure(M) (t/ha)								
	0	0.013a	0.021a	0.012b	0.018b	2097b	626b	1383c
	5	0.012b	0.018b	0.013a	0.015c	2140b	1926a	2012b
	10	0.013a	0.021a	0.012b	0.019a	3148a	2118a	2633a
SE±		0.002	0.003	0.004	0.002	39.0	40.0	35.0
Stand Density(P) (plant/hill)								
	2	0.012	0.018a	0.012b	0.017	2838	1242	2065b
	4	0.012	0.002b	0.013a	0.018	2255	1876	2194a
	6	0.012	0.019a	0.011c	0.018	2292	1550	1768c
SE±		0.004	0.005	0.004	0.005	28.2	39.5	33.5
Interaction								
	P×M	NS	NS	NS	NS	NS	NS	NS
	W x P	NS	NS	NS	NS	NS	NS	NS
	Wx M	NS	NS	NS	NS	**	NS	NS
	Wx M x P	NS	NS	NS	NS	NS	NS	NS

1=WAS: Week after sowing ; 2= Mean followed by the same letter within a column of each treatment group are not significantly different at $P \leq 0.05$ using DMRT 3=.NS: No significant, 4=**: significant @ 5%

ManureT/ha	Weed control treatment				
	0.6 + 0.4	1.2 + 0.8	1.8 + 1.2	HOE WEEDED	WEEDY CHECK
01	461ij	593i	1071h	1269gf	1147h
5	1683ef	1822cde	1771e	1873	1427fg
10	2106c	2836a	2015cd	2499b	306j
SE ±	93.0				

Means followed by unlike letter(s) within same column and row, are statistically different at 5% level of probability using DMRT.

Discussion

Herbicide application and hoe weeding treatments had significant effect on the rice plant has showed by larger leaf Area Index, higher Crop Growth Rate and Relative Growth Rate as well as grain yield compared to weedy check. Throughout the two seasons application of highest rates of Propanil plus 2,4-D at 1.2+0.8, 1.8 +1.2Kg.a.i/ha and two hoe weeding resulted to a higher crop growth rate and increased relative growth rate .This observation could be due to good weed control that allowed the crop to develop more and larger leaves and consequently higher light interception for increased dry matter accumulation per plant per unit area of land.

The weedy check had the least crop growth rate, leaf area index and relative growth rate of rice throughout the experimental periods in the both seasons This may probably be due to severe weed interference posed as a result of serious competition between the rice plant and the uncontrolled weeds in the plot which led to reduction in both growth and yield of rice. The weedy check plots had the highest weed dry weight which resulted in the least crop performance. Ibrahim (2011) and Ishaya (2004) have reported similar findings that uncontrolled plots usually resulted in higher weed dry weight compared to the herbicide and hoe weeding plots. The aggressiveness of weeds when it comes to competition for such growth factors as moisture and nutrients with rice crop might have been the reasons for the low productivity of rice in the weedy check plots.

Effect of Poultry manure.

It can be concluded that the application of essential nutrients which are available in poultry manure was responsible for the significant increase in the growth and yield of rice plants where poultry manure was applied. This result is in line with the work of Reddy *et al*., (1989) that observed that the application of poultry manure has been found to decrease the adsorption capacity and increased the soluble P and Phosphorous desorption. Yanduraju *et al.* (1980) reported that application of poultry manure increased the available P content of the soil and hence increase availability of others nutrients for crop growth and development. The significantly higher plant height, longer panicle, number of tiller, number of filled grain per panicle and grain yield was significantly increased with increase in poultry manure application. Lee *et al*.(2010) reported that, the yield components such as spikelets per panicle, ripened grain and 1000grain weight were significantly increased by application of organic manure. Ali (1993) reported that organic manure in rice double cropping system increased rice yield by up to 3.3ton/ha over the control that received non manure10t/ha of manure applied gave better yield than the other rate. This result is in accordance with the finding of Hossain *et al. (*2009) who observed that grain yield, grain elongation and protein content of the rice were significantly high when manure was applied at 10t/ha than the lower rates

Effect of Stand density

The growth and yield components of rice were also significantly influenced by number of plant per hill, the highest grain yield was obtained by four plants and lowest was by the two plants per hill. This might be due to highest number of bearing tiller per hill, panicle length and grain per panicle. The yield components showed lower performance with increased plant number per hill. The effect was significant in all the cases. It reveals that use of extra plant in a hill did not show any extra benefit to rice farmer in term of yield components. The result was similar to the finding of Mirza *et al.* (2009). that increase in planting density from four plant s per hill show no significant yield increase.

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