EFFECT OF SOWING METHOD ON THE PRODUCTIVITY OF RICE IN MAKURDI, SOUTHERN GUINEA SAVANNA ECOLOGY OF NIGERIA

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ABSTRACT

Experiments aimed at determining the effect of sowing method on the productivity of rice were conducted at the College of Agronomy Teaching and Research Farm of the Federal University of Agriculture, Makurdi during the rain fed cropping seasons of 2011 and 2012. The sowing methods (transplanting and direct seeding) constituted the main plots while seven varieties (four elite hybrids and three adapted varieties) constituted the sub-plots in a split-plot laid out in a randomised complete block design with three replications. Results showed that the direct seeded rice were generally shorter, earlier and with more tillers per stand compared to the transplanted rice. However, the significantly longer days to heading, and consequently longer days to maturity in the transplanted rice, gave more time for the transplanted rice to produce heavier panicles, higher number of panicle branches and seeds/panicle, thereby leading to better grain filling and higher grain yield compared to the direct seeded rice. Three hybrid varieties, namely, PAC 837, INDAM 200-002 and JKR1220 and one adapted variety (FARO 44) recorded the highest grain yield of 9.49t/ha, 7.46t/ha, 7.46t/ha and 7.80t/ha, respectively. These four varieties should be selected for multi – location evaluation using transplanting method of sowing in the Southern Guinea Savanna ecology of Nigeria.

INTRODUCTION

Rice is a staple food for half of the world population and approximately three quarter of a billion of the world's poorest people depend on the staple to survive. In sub-Saharan African, over 20 million farmers grow rice and about 100 million people depend on it for their livelihoods. The demand for rice in Sub-Saharan African is expected to grow substantially as the population is currently growing at the rate of 3-4% per annum and rice consumption is growing faster than that of any major food crop (Vange 2006, WARDA 2005). To attain rice self-sufficiency and meet future demands resulting from population growth, productivity in rice production has to be increased. Rice is one of the important sources of carbohydrate in food basket of many countries in the world including Nigeria (FAO, 1994). Rice is now grown on about 130million hectares in more than 100 countries, mostly in the tropics and subtropics and predominantly Asia (Walter *et al*., 1993). It is valued as the most important staple for over half of the world's population, and ranks third after wheat and maize in world production. More than half of the world depends on rice as the major source of calories (Ogburia *et al*., 2006). West Africa accounts for 64.2% and 61.9% of total rice product and consumption in sub-Saharan Africa respectively. Except for Burkinafaso and Niger, rice is a staple crop throughout West Africa, especially Cote-divoire, the Gambia, Guinea, Guinea Bissau, Liberia, Nigeria, Senegal and Siera Leone. The River Niger basin is a major rice growing environment in the region. Nigeria has a leading role in rice production in West Africa and ranks as both the producer and consumer of rice in the sub-region (Imolehin and Wada 2000).

The trend for the West African sub-region is that the production and consumption of rice is growing faster than for other staple food. The potential for commercial production of rice in West Africa is tremendous (Andriesse 1986). Rice is important in Nigeria for several reasons. It is a major contributor to internal and sub-regional trade. Rice is also a staple for most people in Niger-Benue trough. Farmers find rice more adaptable than a high input staple like maize when there is declining soil fertility because of the huge array of varieties they can switch over to every few years.

The World rice requirement by 2020 would be around 140million tones of which only about 89.5 million tonnes was achieved between 1999 and 2000 (Chhidda *et al*., 2006). There is therefore the need to obviate this deficit through the use of high yielding varieties. Currently, it is believed that high yielding varieties developed through conventional breeding have reached a yield plateau. Among the available genetic options to raise the yield ceiling further, hybrid rice appears to be the most feasible and readily adaptable technology for Nigeria as has been successfully demonstrated in China (Chhidda *et al.*, 2006).

The objective of this study was to determine the effect of sowing method on the productivity of rice in Makurdi, southern guinea savanna ecology of Nigeria.

MATERIALS AND METHODS

Field experiments were conducted at the Teaching and Research Farm of the Federal University of Agriculture, Makurdi in 2011 and 2012 cropping seasons. Makurdi is located on latitude 7.40^{o}N; Longitude 8.37^{o}E; altitude 106m above sea level. Seven varieties consisting of four (4) hybrid rice varieties obtained from India through National Cereal Research Institute (NCRI), Nigeria, and three adapted varieties in commercial production in Nigeria were used for the experiment. The hybrids include PAC 807, PAC 837, INDAM 200-002 and JKR1220 while the two adapted varieties include FARO 52 and FARO 44. Two sowing methods, namely direct seeding and transplanting were employed in the experiment. The experiment was laid out as split-plot in a randomised complete block design with the main plot as the method of sowing while the seven (7) varieties constituted the sub plot in both years. The experiment was replicated three times in each of the years.

For direct seeding, seeds were planted directly into the field at 3-5 seeds per hole which were later thinned down to two seedlings per hill. A spacing of 20 x 20 centimeters was adopted as recommended by Youdeowei (1992). For transplanting, seeds were first raised on portable plastic nursery beds which were later transplanted at two seedlings per hill when the seedlings had attained a height of 15-20cm or at four to five leaf stages when they were three weeks old as recommended by Chhidda *et al*., (2006). Weeds were controlled manually by weeding 3-4 weeks after planting/transplanting and subsequently as the weeds re-appear.

Fertilizers were applied at the rate of 60kg N, 30kg %P_2O_5 and 30kg %K_2O/ha as N – P – K fertilizer and later top dressed with 23kg N as Urea (46%) during panicle initiation/development as recommended by NCRI Baddegi, Nigeria. The recommended dose for the research plots were computed using the formula recommended by Avav and Ayuba (2006).
Agronomic parameters assessed include plant height, number of tillers per stand, panicle length, number of panicle branches, number of seeds per panicle, panicle weight, 100 seed weight, days to 50% heading and grain yield. All linear measurement were made using a tape

graduated in centimetres, while weights were taken using an electronic sensitive mettle balance and data relating to count were made by simple numerical counting.

Data obtained from the experiments were analyzed using Analysis of variance ANOVA for each method of production while means were separated using Duncan's multiple range test (DMRT).

RESULTS

Meteorological data for rainfall distribution for the years 2011 and 2012 are presented in Table 1. Mean squares for analysis of variance (ANOVA) for grain yield and other agronomic traits (days to 50% heading, plant height, number of tillers per stand, panicle length, panicle branches/plant, panicle weight, number of seeds/panicle and 100 seed weight) in transplanted and direct seeded rice in 2011 and 2012 are summarized in Table 2. Highly significant difference in method of sowing was observed for plant height, number of tillers per stand, number of panicle branches, number of seeds/panicle, panicle weight/plant and grain yield. Significant difference in sowing method was observed for days to heading. Highly significant difference in variety was observed for almost all the traits (days to 50% heading, plant height, number of tillers per stand, panicle length, number of panicle branches/plant, number of seeds per panicle, 100 seed weight, and grain yield) except panicle weight. Sowing method X variety interaction was highly significantly different for only four traits, namely, days to 50% heading, number of seeds per panicle, 100 seed weight, and grain yield.

Heading was earlier in the direct seeded (104.38 days) compared to the transplanted rice (112.60 days) (Table 3). Plants were generally taller, with fewer tillers in the transplanted rice compared to the direct seeded rice. The transplanted rice however performed better in terms of grain yield and the yield components of number of panicle branches/plant, number of seeds per panicle and panicle weight/plant.

Days to heading in the hybrid PAC 837 was significantly longer (113.67 days) compared to that of all the other varieties except FARO 44 (111.17 days) (Table 4). The hybrid PAC 837 also produced the highest number of tillers/stand and the highest grain yield. The worst performance in terms of number of tillers per stand, panicle length, number of panicle branches/plant, number of seeds per panicle and panicle weight was observed for PAC 807.
Days to heading ranged from less than 100 days for the hybrid PAC 807 in the direct seeded method to 120 days for the hybrid PAC 837 in the transplanted rice (Fig. 1). The variety FARO 52 was however consistent in the number of days to heading for the two methods.

Sowing method X variety interaction was conspicuously observed in terms of number of seeds/panicle in Fig. 2. While the number of seeds/panicle was lowest in FARO 44 and highest in the hybrid JKR 1220 for the direct seeded method, the trend in the transplanted rice was completely different. The hybrid, PAC 807 produced the least number of seeds/panicle, while FARO 57 produced the highest number of seeds/panicle in the transplanted rice.

The variety FARO 52 recorded the least 100 seed weight in both direct seeded and transplanted rice (Fig. 3). However, the highest 100 seed weight was observed for FARO 44 and PAC 837 hybrid in the direct seeded and transplanted rice respectively. The grain yield observed for each of the varieties in the transplanted rice was much higher (4.24t/ha – 9.49t/ha) compared to the yield obtained for their counterparts in the direct seeded rice

(1.36t/ha – 4.70t/ha), except FARO 52 (Fig. 4). Four varieties, namely, PAC 837, FARO 44, INDAM 200-002 and JKR1220 recorded the highest grain yield of 9.49t/ha, 7.80t/ha, 7.46t/ha and 7.46t/ha respectively. The variety, FARO 52, was almost consistent in performance, recording a slightly higher grain yield in the direct seeded rice (4.70t/ha) compared to the transplanted rice (4.24t/ha).

DISCUSSION

The significantly longer days to heading, and consequently longer days to maturity for all the varieties except FARO 52, gave the transplanted rice more time to significantly produce heavier panicles, higher number of panicle branches and seeds/panicle, thereby leading to better grain filling and higher yield compared to the direct seeded rice.

The consistently higher grain yield in the transplanted compared to the direct seeded rice observed for all the varieties except FARO 52, is an indication of the need for preference of the former over the later method of sowing in rice production for the study area. The slightly higher grain yield recorded for FARO 52 in the direct seeded compared to the transplanted rice, is an indication that this variety is better adapted to the direct seeded method of rice production in the study area.

The current yield of >7t/ha observed for three of the four hybrids and FARO 44 far exceed the values reported by Vange (2009) and Adesanwo et al. (2009) for the Southern Guinea Savanna (Makurdi) and the rain forest ecologies of Nigeria. These three hybrids (PAC 837, INDAM 200-002 and JKR1220) and FARO 44 (adapted variety} should be selected for multi – location evaluation using transplanting method of sowing in the Southern Guinea Savanna ecology of Nigeria.

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Table 1: Meteorological data of Makurdi in 2011 and 2012

Year	Month	No. of rainy days	Total rainfall (mm)	Av. Max Temp. (^{o}C)	Av. Min Tem. (^{o}C)	Av. Max Relative Humidity (%)	Av. Min. Relative Humidity (%)
2011	January	-	-	34.3	16.5	49	28
	February	3	66.8	35.3	24.4	74	44
	March	-	-	37.0	26.2	68	37
	April	7	78.0	35.3	25.0	76	45
	May	7	142.8	33.0	24.0	80	46
	June	6	60.4	31.1	22.6	78	46
	July	12	87.0	30.7	22.0	79	45
	August	14	217.4	29.5	22.4	82	64
	September	10	272.0	30.3	21.9	83	66
	October	18	293.4	30.8	21.6	84	70
	November	-	-	34.0	19.4	75	52
	December	-	-	34.5	14.5	50	28
2012	January	-	-	34.6	18.3	47	26
	February	-	-	35.9	22.7	66	38
	March	-	-	38.2	23.5	71	38
	April	6	143.2	35.2	22.8	80	53
	May	11	145.2	31.9	21.4	83	64
	June	8	160.6	30.6	21.1	85	70
	July	13	351.9	29.8	20.6	85	73
	August	13	174.3	29.4	20.6	85	74
	September	13	190.7	30.2	20.5	84	73
	October	16	199.1	31.1	20.4	83	68
	November	1	27.3	33.4	20.7	79	55
	December	-	-	34.5	15.5	53	30

Table 2: Mean squares from analysis of variance for grain yield and other agronomic traits in rice during the 2011 and 2012 rain fed cropping season in Makurdi, Nigeria

Source	d.f	Days to 50% heading	Plant height	No. of tillers/ Plant	Panicle length	Panicle branches /plant	No. of seeds per panicle	Panicle weight/ plant	1000 seed weight	Grain Yield (t/ha)
Rep	**2**	**4.08**	**75.93**	**15.72**	**3.49**	**2.18**	**2011.28**	**1.76**	**0.44**	**3.40**
Rep (year)	**3**	**8542.49**	**11.69**	**403.17**	**35.85**	**0.32**	**120.70**	**4.83**	**0.89**	**134.31**
SownMeth	**1**	**1416.49***	**684.17NS**	**255.02****	**8.71NS**	**16.98****	**72688.58****	**17.71****	**0.31NS**	**218.64****
Error a	**5**	**217.16**	**122.44**	**16.74**	**3.41**	**0.76**	**1676.38**	**1.16**	**1.01**	**24.13**
Variety	**6**	**124.43****	**1037.93****	**29,60****	**40.35****	**4.45****	**19024.17****	**0.59NS**	**18.26****	**13.70****
SownMeth x Variety	**6**	**89.77****	**135.39NS**	**7.88NS**	**4.23NS**	**0.48NS**	**13426.22****	**0.10NS**	**11.50****	**15.55****
Error b	**60**	**14.12**	**182.23**	**8.21**	**3.96**	**0.78**	**1464.53**	**0.32**	**1.28**	**5.07**

***, ** = Significant at P ≤ 0.05 and P ≤ 0.01 respectively. NS = Not Significant at P ≤ 0.05 or P ≤ 0.01**

Table 3: Mean performance of transplanted and direct seeded rice during the 2011 and 2012 rain fed cropping seasons in Makurdi, Nigeria

Method of planting	Days to 50% heading	Plant height	No. of tillers per plant	Panicle length	No of panicle branches	No of seed per panicle	Panicle weight	100 seed weight	Grain Yield (t/ha)
Transplanted	112.60	95.10	13.89	27.52	10.66	255.20	3.89	26.63	6.68
Direct seeded	104.38	89.40	17.37	26.87	9.76	196.30	2.98	26.51	3.45
LSD $_{(0.05)}$	8.27	NS	2.29	NS	0.49	22.97	0.60	NS	2.76

Table 4: Mean performance of rice varieties during 2011 and 2012 rainfed cropping season in Makurdi, Nigeria

Variety	Days to 50% heading	Plant height	No. of tillers per plant	Panicle length	No of panicle branches	No of seeds per panicle	Panicle weight per plant	100 seed weight	Yield (t/ha)
PAC 807*	105.17d	82.94c	13.49c	23.50c	9.31cd	162.50d	3.05a	25.83c	4.57ab
PAC 837*	113.67a	94.82ab	18.17a	28.91ab	10.50abc	221.42bc	3.59a	27.60ab	6.32a
FARO 57	110.17bc	108.29a	15.92abc	29.38a	11.01a	289.75a	3.68a	26.18c	3.16b
INDAM 200-002*	105.92d	99.99ab	16.09ab	27.45b	9.72cd	232.67b	3.33a	26.65bc	5.99a
JKR 1220*	105.92d	89.06bc	14.80bc	27.35b	10.13bc	226.67bc	3.65a	27.28ab	5.57a
FARO 52	107.42cd	85.11c	14.30b	28.56ab	10.73ab	249.50b	3.46a	24.40c	4.47ab
FARO 44	111.17ab	85.37c	16.64ab	27.16b	10.01bcd	197.75c	3.32a	28.03a	5.25a

* Hybrid line

Means followed by the same letters are not significantly different at $P \leq 0.05$

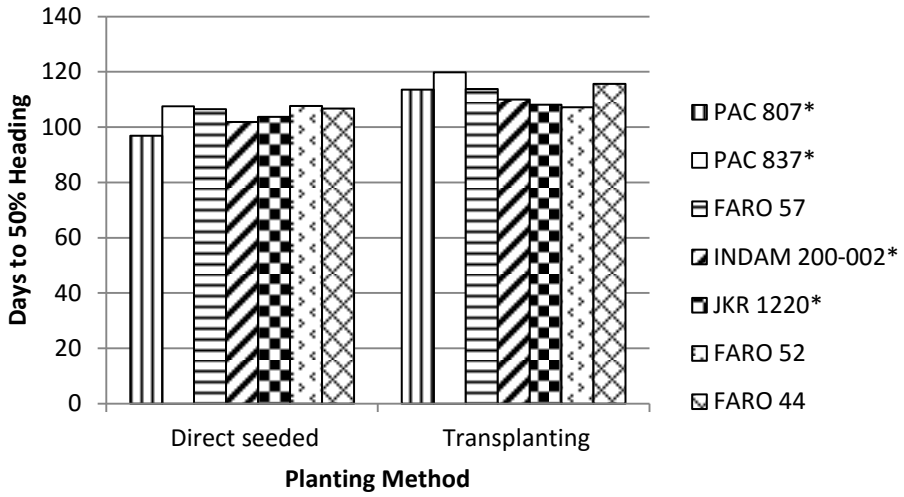

Figure 1: Effect of Planting Methods on Days to 50% heading of Rice varietal types

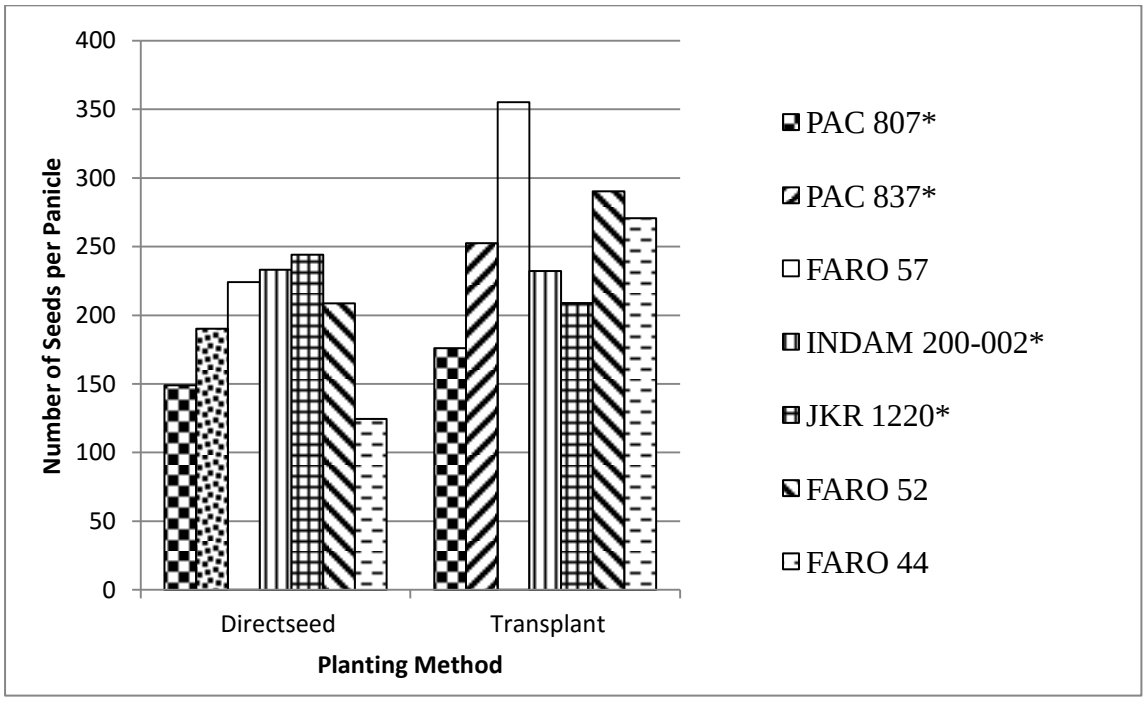

Figure 2: Effects of Planting Methods on Number of Seeds per panicle of Rice varietal types

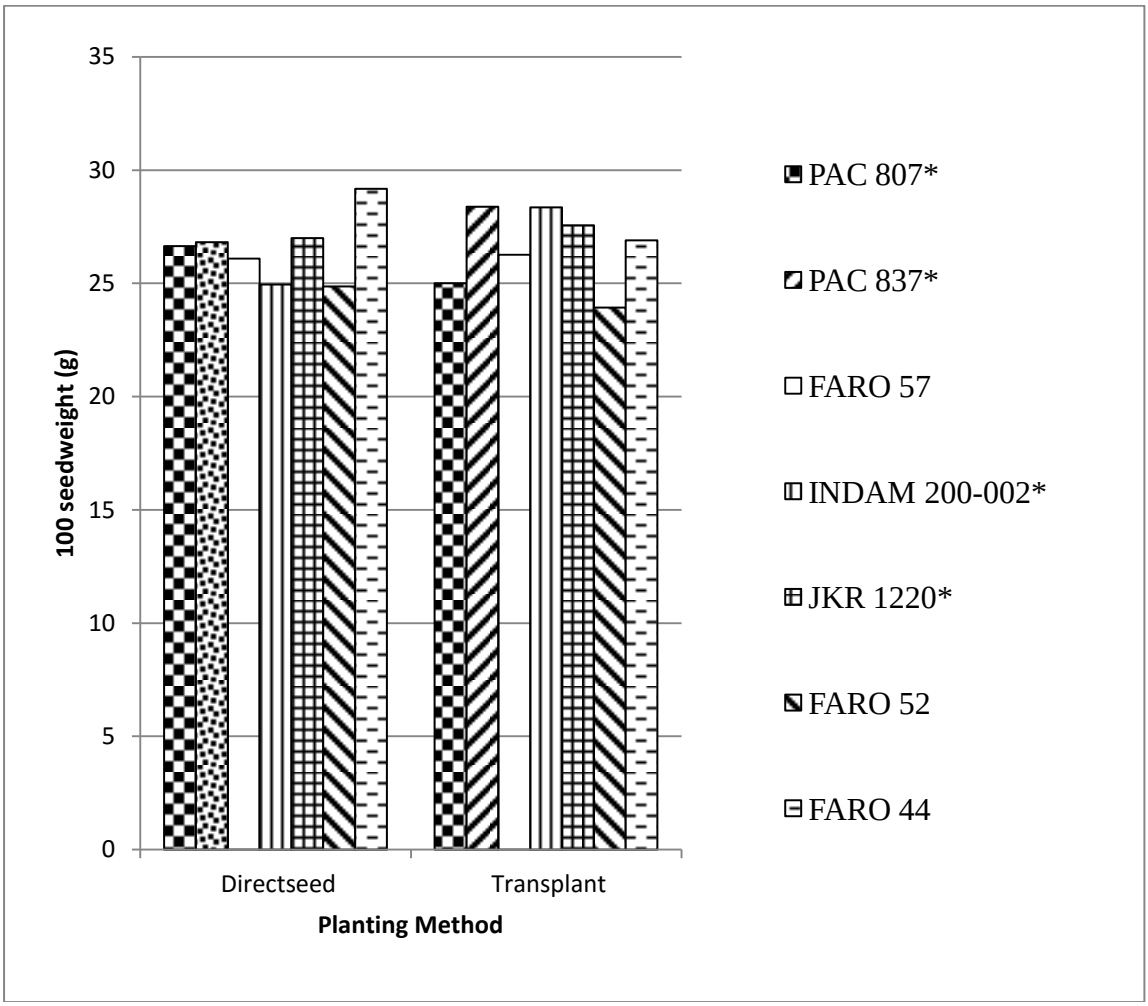

Figure 3: Effects of Planting Methods on 100 Seeds weight of Rice varietal types

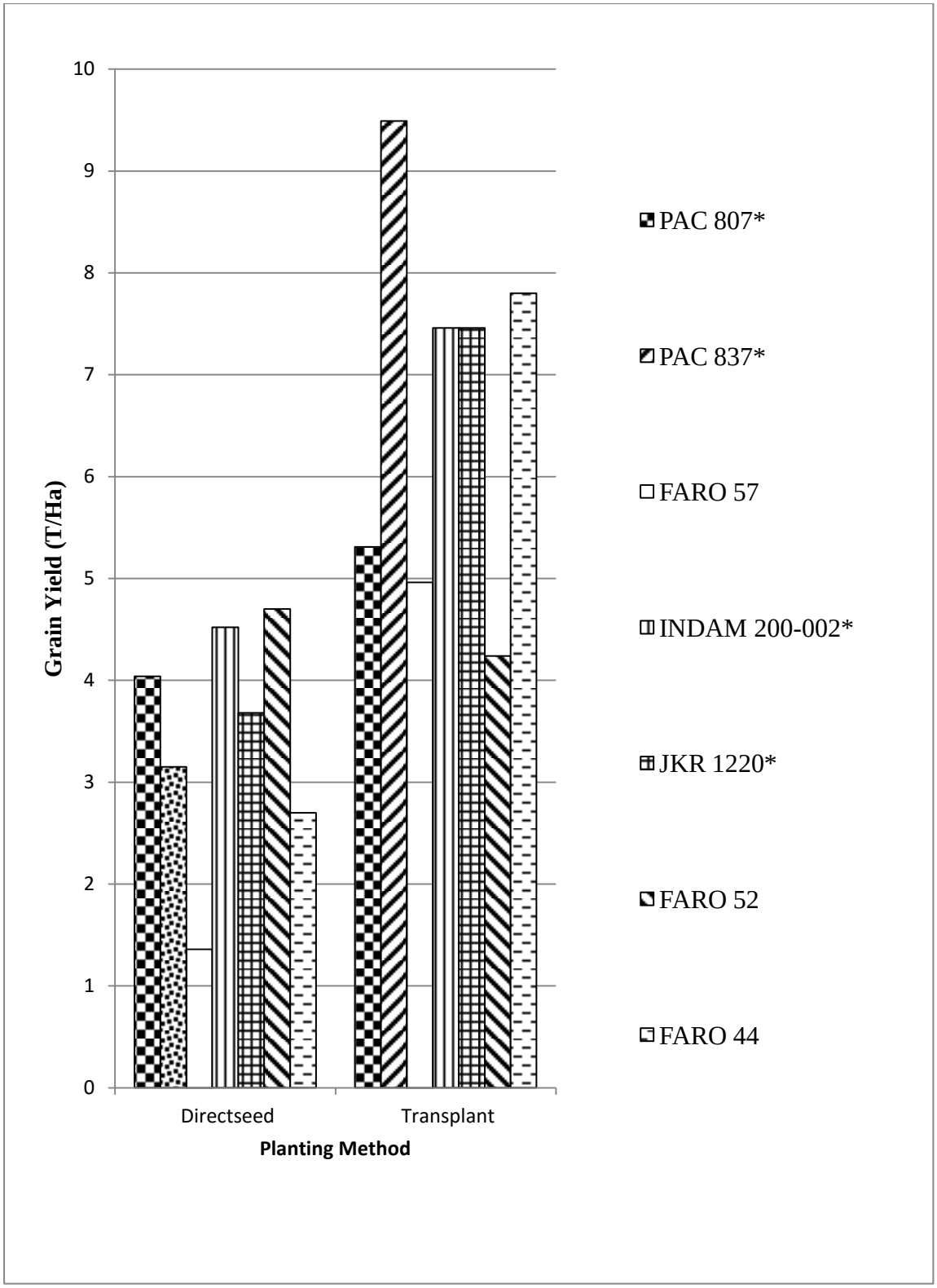

Figure 4: Effects of Planting Methods on Grain Yield of Rice varietal types