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Effect of nursery seeding density, age of seedling and number of seedlings hill^{-1} on the performance of short duration transplanted *Aus* rice (cv. Parija)

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Abstract

The cultivar Parija is a short duration transplanted *Aus* rice, which can be cultivated in between *Boro* and transplanted *Aman* rice without hampering their yield. Hence, research work on proper agronomic practices warrant due attention to augment the grain yield of this cultivar. An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during April to July 2012 to examine the effect of nursery seeding density, age of seedling and number of seedlings hill^{-1} and their effects on the yield components and yield of short duration transplant *Aus* rice (cv. Parija). The experiment consisted of two nursery seeding densities viz. 40, 80 g seeds m^{-2}, three ages of seedlings viz. 20-, 30- and 40-day old and three levels of seedlings hill^{-1} *viz.* 2, 4 and 6 seedlings hill^{-1}. The experiment was laid out in a Randomized Complete Block Design with three replications. The results showed that the treatments 40 g seed m^{-2} × 30-day old seedlings × 4 seedlings hill^{-1} individually had significant effect on the total tillers hill^{-1}, effective tillers hill^{-1}, grains panicle^{-1} and sterility percentage. In consequence, the highest grain yields of 3.28, 3.35 and 3.5 t ha^{-1} were found at 40 g seed m^{-2}, 30-day old seedlings and 4 seedlings hill^{-1}, respectively. In case of interaction the highest grain yield (4.22 t ha^{-1}) was found in 40 g seed m^{-2} × 30-day old seedlings × 4 seedlings hill^{-1} which was at par with the interaction of 40 g seed m^{-2} × 30-day old seedlings × 6 seedlings hill^{-1} (3.84 t ha^{-1}) and 80 g seed m^{-2} × 30-day old seedlings × 4 seedlings hill^{-1}. Considering both the individual and cumulative significant effects of the treatments on the yield components and grain yield, the use of 40 g seed m^{-2}, 30-day-old seedlings and 4 seedlings hill^{-1} could improve the yield components and grain yield of short duration transplanted *Aus* rice (cv. Parija). Therefore, short duration transplanted *Aus* rice (cv. Parija) can be cultivated maintaining a nursery seeding density of 40 g seed m^{-2} and 30-day old seedlings with 4 seedlings hill^{-1} for obtaining maximum grain yield.

Introduction

Rice (*Oryza sativa* L.) is the major grain crop and staple food crop in Bangladesh. The climatic condition of this country is very suitable for its cultivation. There are three distinct rice growing seasons namely *Aus*, *Aman* and *Boro* in Bangladesh. Areas under rice cultivation in Bangladesh are *Aus* 8.94%, *Aman* 49.12% and *Boro* 41.94% (BBS, 2016). The farmers usually complete their *Boro* rice harvesting in April–May thereafter, start the cultivation of *Aman* rice on the same land at the end of July. As a result their land remains vacant for more or less two and a half months in between *Boro* and *Aman* rice.

A short duration indigenous rice variety cv. Parija may be cultivated as a completely off-season crop in between late May and mid-August. If the farmers cultivate Parija on their vacant land with proper agronomic management in between *Boro* and *Aman* season they may have an additional rice crop with appreciable yield. In Bangladesh, yield of rice is far below the levels obtained in other rice producing countries, in spite of growing high yielding varieties. There are several reasons behind this but one of the most important is that nurseries are not properly managed to obtain vigorous seedlings for uniform stand and better seedling establishment. Among the different components of nursery management, adequate nutrition, better seeding densities and transplanting seedlings at the appropriate age are regarded as important factors to obtain vigorous stands after transplanting (Lal and Roy, 1996). Yield and yield components of rice crop are affected negatively by using a higher seed rate at the nursery level, while yields increase when a lower seeding rate is used in the nursery (Singh *et al.*, 1987). Sarwar *et al.* (2011) reported more productive tillers and higher yield unit^{-1} area by planting healthy and vigorous seedlings, which might be due to the decreased mortality rate after transplanting. Timely planting and appropriate seedling age at transplanting can be an important and cheap practice for higher productivity in rice. The age of seedlings at transplanting is important because it is one of the factors determining the number of tillers produced hill^{-1}. It has a direct effect on plant height, effective tillers, length of panicles, grains panicle^{-1} and other yield attributing characters (Adhikari *et al.*, 2013). The many above- and below-ground characteristics of rice plants (seedling vigour), before and after transplanting vary with seedling age, growing environment and seeding rate (Sasaki, 2004). There was a positive impact on grain yield by using seedlings not older than 25 days (Thanunathan and Sivasubramanian, 2002). BRRI has recommended seedling age of rice transplantation based on growing season, such as 20–30 days for the *Aus* season, 20–35 days for the T. *Aman* season and 40–45 days for the *Boro* season (BRRI, 1990). The number of tillers and their growth is greatly affected both qualitatively and quantitatively by number of seedlings hill^{-1} . Optimum number of seedlings hill^{-1} may enable the rice plant to grow properly both in its aerial and underground parts by utilizing maximum solar energy, nutrients, space, water and also could reduce seedling cost of farmers (Azad, 2004). On the basis of above reviews this study was undertaken to find out the effect of nursery seeding density, age of seedlings and number of seedlings hill^{-1} on the yield components and yield of short duration transplanted *Aus* rice (cv. Parija).

Materials and Methods

An experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during April to July 2012 to study the effect of seeding density in nursery bed, age of seedling and number of seedlings hill^{-1} on the yield components and yield of short duration transplanted *Aus* rice (cv. Parija). The experimental site is located at 24^{0}75′ N latitude and 90^{0}50′E longitude having an altitude of 18m. The site belongs to the Sonatala series of Old Brahmaputra Floodplain Agroecological Zone (AEZ-9) having non-calcareous dark grey floodplain soils (UNDP and FAO, 1998). The land was medium high having sandy loam texture with low organic matter content and pH 6.8. The study comprised two seeding densities *viz.* 40, 80 g sedes m^{-2}, three ages of seedlings *viz*. 20-, 30- and 40-day old and three levels of seedlings hill^{-1} *viz.* 2, 4 and 6 seedlings hill^{-1}. The experiment was laid out in a Randomized Complete Block Design with three replications. The net size of each unit plot was 4.0 m × 2.5 m. A short duration local variety of *Aus* rice cv. Parija was used as the test crop. Sprouted seeds were broadcasted uniformly in a well prepared nursery bed on 26 March, 5 April and 15 April. The land was first opened with a tractor driven ploughing followed by cross ploughing with a country plough and leveled using a ladder. Weeds and stubble were removed from the field as much as possible after leveling. The lands were finally prepared and the plots were laid out on 7 May. In addition to nitrogen a basal dose for each of triple super phosphate, muriate of potash, gypsum and zinc sulphate at the rate of 90, 60, 38 and 8 kg ha^{-1}, respectively were applied in all plots. Nitrogen fertilizer in the form of urea was applied in two equal splits at 10 and 30 days after transplanting (DAT). As per experimental specification 20, 30 and 40-day old seedilings were transplanted on 8 May maintaining 20 cm × 15 cm spacing using specified seedlings hill^{-1}. Constant water depth of 5–7 cm was maintained in the experimental field throughout the growing period. The crop was harvested at full maturity when 90% of the grain became golden yellow in color. Five hills (excluding border rows and central 1 m^2 harvest area) were selected randomly from each unit plot and uprooted for recording data on crop characters and yield components. After sampling a harvest area of central 1m × 1m was selected from each unit plot and harvested on 28 June. The harvested crop of each plot was separately bundled, properly tagged and then brought to threshing floor. The crop was threshed by pedal thrasher and the fresh weights of grains straw were recorded plot wise. The grains were cleaned and sun dried to a moisture content of 14%. Finally grain and straw yields plot^{-1} were recorded and converted to t ha^{-1}. The harvest index was computed by using the following formula :

$$\text{Harvest index} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Data on different parameters were compiled and tabulated in proper form for statistical analysis. Analysis of variance was done with the help of computer package MSTAT. The mean differences among the treatments were adjudged with Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Plant height

Plant height is an important physical trait that is controlled by the genetic make-up of the plant as well as the growing conditions, seedling vigour, planting density and nutrient management. Table 1 shows that there was no significant effect of nursery seeding density and age of seedlings on plant height at harvest except for number of seedlings transplanted hill^{-1}. The highest plant height was found in 4 seedlings transplanted hill^{-1} (71.42 cm) followed by 6 seedlings transplanted hill^{-1} (70.80 cm) while the lowest one (66.76 cm) was found in 2 seedlings transplanted hill^{-1}. Probably, the 4 seedlings hill^{-1} enhanced the vigorous stem elongation compared to that of other seedlings hill^{-1}. Variations in plant height due to number of seedlings hill^{-1} were also reported elsewhere (Faruk *et al.*, 2009: Khan *et al.*, 2015). The interaction effect of nursery seeding density × age of seedlings, seeding density × number of seedlings hill^{-1}, age of seedlings × number of seedlings hill^{-1}and nursery seeding density × age of seedlings × number of seedlings hill^{-1} had no significant effect on plant height (Tables 2–5).

Tiller Production

Table 1 shows that the nursery seeding density, seedling age and number of seedlings hill^{-1} had statistically significant effect on total tillers and productive tillers hill^{-1}. The maximum number of total tillers hill^{-1} (12.44) and productive tillers hill^{-1} (9.33) were recorded in 40 g seeds m^{-2} while the minimum number for the both (11.41 and 8.26, respectively) were found in 80 g seeds m^{-2} (Table 1). The highest number of total tillers (12.22) and productive tillers hill^{-1} (9.72) were recorded in 30-day old seedlings which was as good as 20-day old seedlings (Table 1). Thirty-day old seedling produced the highest tillers which supports the findings of Faruk *et al.* (2009). Mishra and Salokhe (2008) reported higher number of effective tillers after transplanting younger seedlings. The author also reported that younger seedling enhance tillers unit^{-1} area irrespective of seeding densities and fertilizer application at the nursery level. Four seedlings transplanted hill^{-1} produced the highest number of total tillers (13.11) and effective tillers hill^{-1} (9.56) followed by 6 seedlings transplanted hill^{-1} while the lowest values were found in 2 seedlings transplanted hill^{-1} (Table 1). The results of more total tillers and productive tillers after the use of low seeding density in the nursery are most likely due to lower seedling competition for nutrient, light and space resulting in more vigorous seedlings. In the low-density nursery, tiller formation started in the nursery itself whereas no tillers formed in the high-density nursery. Interaction effect of low seeding densities (40 g seed m^{-2}) × 30-day old seedling age, low seeding densities × 4 seedlings hill^{-1} and low seeding density (40 g seed m^{-2}) × 30-day old seedling × 4 seedlings hill^{-1} gave the highest number of total tillers as well as effective tillers hill^{-1} (Table 2-5). Alam *et al.* (2002) also found that 35-day old seedlings performed better than 28 or 21-day old seedlings regarding the number of tillers hill^{-1} and the number of effective tillers hill^{-1}. Faruk *et al.* (2009) concluded that the combination of four weeks aged seedling with two seedlings hill^{-1} showed the best performance in respect of the number of effective tillers.

Grains panicle^{-1} and sterility percentage

Number of grains panicle^{-1} is an important yield component of rice. Nursery seeding density, age of seedling and number of seedlings hill^{-1} exerted significant effect on number of grains panicle^{-1} (Table 1). Low nursery seeding densities (40 g seed m^{-2}) produced higher number of grains panicle^{-1} (92.78) with lower sterility percentage (16.19%) compared to the high nursery seeding density (80 g seed m^{-2}). Higher number of grains panicle^{-1} (90.44) and lower sterility percentage (17.72) were recorded when 30-day old seedlings were transplanted followed by 20-day old seedlings whereas 40-day old seedlings produced the lowest number of grains panicle^{-1} (64.04) with the higher sterility percentage (32.91%). The highest number of grains panicle^{-1} with least sterility percentage was found in four seedlings hill^{-1}. In respect of these two traits, 2 seedlings hill^{-1} appeared as the inferior one (Table 1). Table 1 also shows that the higher the grains panicle^{-1}, the lower the sterility percentage of grains. The number of grains panicle^{-1} was significantly affected by nursery seeding density × number of seedlings hill^{-1} and nursery seeding density × age of seedlings × number of seedlings hill^{-1} (Table 3 and Table 5). The highest number of grains panicle^{-1} (134.00) were recorded in nursery seeding density 40 g m^{-2} × 30- day old seedlings × 6 seedlings hill^{-1} while the lowest one (13.33) was recorded in nursery seeding density 80 g m^{-2} × 20- day old seedlings × 2 seedlings hill^{-1}. Sterility percentages were significantly influenced by all of the interactions (Tables 2–5). The highest sterility percent (88.11%) was obtained in nursery seeding density of 80 g m^{-2} × 40–day old seedlings × 2 seedlings hill^{-1} while the lowest one (3.84) was recorded in nursery seeding density 40 g m^{-2} × 30- day old seedlings × 6 seedlings hill^{-1} (Table 5).

1000-grain weight

1000-grain weight is an important yield contributor that depends on genetic makeup and is least affected by growing conditions (Ashraf *et al.*, 1999). The effect of seeding density, age of seedling and number of seedlings hill^{-1} and their interactions on 1000-grain weight was found as non-significant (Tables 1–5), which agrees to the findings of Brar *et al.* (2012) and Ashraf *et al.* (1999) but differed from the results of Sarkar *et al.* (2011) and Rahimpour *et al.* (2013). The differences among the results could be due to differences in genetic characters of variety and the particular environmental conditions.

Grain yield

The grain yield was significantly influenced by the seeding density, age of seedling and number of seedlings hill^{-1} as well as their interactions (Tables 1–5). Low seeding densities (40 g seed m^{-2}), moderate seedling age (30-day old) and 4 seedlings hill^{-1} treatments produced the highest grain yield (3.28, 3.35 and 3.50 t ha^{-1}, respectively) (Table 1). The highest grain yield was found because of the superior performance of the yield components and the lowest grain sterility percentage for the respective treatments. Adhikari *et al.* (2013) also found the highest grain yield from low seeding density. The highest grain yield was also resulted from 4 weeks older seedlings as reported by Faruk *et al.* (2009). Table 5 points up that the highest grain yield (4.22 t ha^{-1}) was found in the interaction of 40 g seed m^{-2} × 30-day old seedlings × 4 seedlings hill^{-1} which was statistically identical with the interaction of 40 g seed m^{-2} × 30-day old seedlings × 6 seedlings hill^{-1} (3.84 t ha^{-1}) and the interaction of 80 g seed m^{-2} × 30-day old seedlings × 4 seedlings hill^{-1} (3.70 t ha^{-1}). These findings indicate the importance of good nursery bed management, seedling and tiller number hill^{-1}in transplanted *Aus* rice cultivation as agreed by Adhikari *et al.* (2013). The lowest grain yield (1.48 t ha^{-1}) was found in the interaction of 80 g seed m^{-2} × 40-day old seedlings × 2 seedlings hill^{-1} because of the lowest number of tillers hill^{-1} and the highest grain sterility percentage (Table 5).

Table 1. Effect of nursery seeding density, age of seedlings and number of seedlings hill^{-1} on yield components and yield of short duration transplanted *Aus* rice (cv. Parija)

Treatments	Plant height (cm)	Total tillers hill^{-1} (no.)	Productive tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterility (%)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
Seeding density									
D_1 (40 g m^{-2})	70.23	12.44a	9.33a	92.78a	16.19b	24.71	3.28a	3.85a	45.95a
D_2 (80 g m^{-2})	69.09	11.41b	8.26b	58.70b	35.86a	24.66	2.88b	3.50b	44.58b
CV (%)	3.91	8.98	10.09	3.9	19.36	3.45	6.96	18.38	10.54
Level of Sig.	NS	**	**	**	**	NS	**	**	*
Age of seedlings (days)									
A_1 (20)	68.82	12.11a	8.50ab	72.72b	27.45b	24.79	3.01ab	3.61ab	45.24
A_2 (30)	70.97	12.22a	9.72a	90.44a	17.72c	24.68	3.35a	3.89a	46.02
A_3 (40)	69.19b	11.44b	8.17b	64.06c	32.91a	24.58	2.87b	3.51b	44.53
CV (%)	3.91	8.98	10.09	3.9	19.36	3.45	6.96	18.38	10.54
Level of Sig.	NS	**	**	**	**	NS	**	*	NS
Number of seedlings hill^{-1}									
H_1 (2)	66.76c	10.56c	7.89c	31.39c	49.82a	24.42	2.39b	3.18c	42.58c
H_2 (4)	71.42a	13.11a	9.56a	104.00a	10.70c	24.67	3.50a	4.09a	46.06b
H_3 (6)	70.80b	12.11b	8.94b	91.83b	17.55b	24.96	3.35b	3.75b	47.16a
CV(%)	3.91	8.98	10.09	3.9	19.36	3.45	6.96	18.38	10.54
Level of Sig.	**	**	**	*	**	NS	**	*	**

In a column, values having the same letters under each treatment do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT.
* = Significant at 5% level of probability. ** = Significant at 1% level of probability. NS = Not significant.
D_1 = 40 g seeds m^{-2}, D_2 = 80 g seeds m^{-2}; A_1= 20-days old, A_2= 30-days old, and A_3= 40-days old seedling, H_1= 2 seedlings hill^{-1}, H_2= 4 seedlings hill^{-1}, and H_3= 6 seedlings hill^{-1}

Table 2. Effect of interaction between nursery seeding density and age of seedlings on yield components and yield of short duration transplanted *Aus* rice (cv. Parija)

Interaction (seeding density × age of seedling)	Plant height (cm)	Total tillers hill^{-1} (no.)	Productive tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterility (%)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$D_1 \times A_1$	69.47	12.33b	8.56b	90.00	17.38d	24.72	3.28ab	3.78	46.66
$D_1 \times A_2$	71.60	13.11a	11.44a	105.78	11.63e	24.90	3.57a	4.09	46.37
$D_1 \times A_3$	69.61	11.89bc	8.00b	82.56	19.57cd	24.52	2.98bc	3.67	44.82
$D_2 \times A_1$	68.16	11.89bc	8.44b	55.44	37.52b	24.86	2.74c	3.45	43.83
$D_2 \times A_2$	70.34	11.33cd	8.00b	75.11	23.81c	24.47	3.13b	3.70	45.68
$D_2 \times A_3$	68.78	11.00d	8.33b	45.56	46.24a	24.63	2.76c	3.34	44.24
CV(%)	3.91	8.98	10.09	3.9	19.36	3.45	6.96	18.38	10.54
Level of Sig.	NS	*	**	NS	**	NS	**	*	NS

In a column, values having the same letter or without letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT. * = Significant at 5% level of probability.
** = Significant at 1% level of probability. NS = Not significant.
D_1 = 40 g seeds m^{-2}, D_2 = 80 g seeds m^{-2}; A_1= 20-days old, A_2= 30-days old, and A_3= 40-days old seedling

Table 3. Effect of interaction between nursery seeding density and number of seedlings hill^{-1} on yield components and yield of short duration transplanted *Aus* rice (cv. Parija)

Interaction (seeding density × number of seedlings hill^{-1})	Plant height (cm)	Total tillers hill^{-1} (no.)	Productive tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterility (%)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$D_1 \times H_1$	67.24	11.33b	8.56b	46.33e	30.51b	24.36	2.76c	3.46	44.56b
$D_1 \times H_2$	71.52	13.22a	9.67a	121.78a	5.76e	24.92	3.61a	4.25	45.80ab
$D_1 \times H_3$	71.92	12.78a	9.78a	110.22b	12.31d	24.85	3.47ab	3.84	47.48a
$D_2 \times H_1$	66.28	9.78c	7.22c	16.44f	69.13a	24.48	2.01d	2.90	40.60c
$D_2 \times H_2$	71.31	13.00a	9.44a	86.22c	15.64d	24.42	3.39ab	3.92	46.32ab
$D_2 \times H_3$	69.68	11.44b	8.11b	73.44d	22.79c	25.07	3.23b	3.67	46.84ab
CV(%)	3.91	8.98	10.09	3.9	19.36	3.45	6.96	18.38	10.54
Level of Sig.	NS	*	*	*	**	NS	*	NS	*

In a column, values having the same letter or without letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT. * = Significant at 5% level of probability.
** = Significant at 1% level of probability. NS = Not significant
D_1 = 40 g seeds m^{-2}, D_2 = 80 g seeds m^{-2}; H_1= 2 seedlings hill^{-1}, H_2= 4 seedlings hill^{-1}, and H_3= 6 seedlings hill^{-1}

Table 4. Effect of interaction between age of seedling and number of seedlings hill^{-1} on yield components and yield of short duration transplanted *Aus* rice (cv. Parija)

Interaction (Age of seedling × number of seedlings hill^{-1})	Plant height (cm)	Total tillers hill^{-1} (no.)	Productive tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterility (%)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$A_1 \times H_1$	67.32	10.67	7.83	27.67	52.68b	24.17	2.53c	3.24	43.40
$A_1 \times H_2$	70.83	13.50	9.17	102.83	10.71fg	25.10	3.14b	3.96	44.24
$A_1 \times H_3$	68.30	12.17	8.50	87.67	18.97de	25.11	3.37b	3.65	48.09
$A_2 \times H_1$	66.72	10.50	8.50	45.17	33.66c	24.81	2.57c	3.52	42.35
$A_2 \times H_2$	72.61	13.67	10.67	117.67	7.62g	24.31	3.96a	4.35	47.65
$A_2 \times H_3$	73.59	12.50	10.00	108.50	11.88fg	24.93	3.53b	3.81	48.06
$A_3 \times H_1$	66.26	10.50	7.33	21.33	63.13a	24.28	2.07d	2.78	41.99
$A_3 \times H_2$	70.81	12.17	8.83	91.50	13.77ef	24.61	3.40b	3.95	46.27
$A_3 \times H_3$	70.51	11.67	8.33	79.33	21.82d	24.84	3.15b	3.80	45.32
CV(%)	3.91	8.98	10.09	3.9	19.36	3.45	6.96	18.38	10.54
Level of Sig.	NS	NS	NS	NS	**	NS	*	NS	NS

In a column, values having the same letter or without letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT. * = Significant at 5% level of probability. ** = Significant at 1% level of probability. NS = Not significant.
A_1= 20-days old, A_2= 30-days old, and A_3= 40-days old seedling,
H_1= 2 seedlings hill^{-1}, H_2= 4 seedlings hill^{-1}, and H_3= 6 seedlings hill^{-1}

Table 5. Effect of interaction between nursery seeding density, age of seedlings and number of seedlings hill^{-1} on yield components and yield of short duration transplanted *Aus* rice (cv. Parija)

Interaction (Seeding density × age of seedling × number of seedlings hill^{-1})	Plant height (cm)	Total tillers hill^{-1} (no.)	Productive tillers hill^{-1} (no.)	Grains panicle^{-1} (no.)	Sterility (%)	1000- grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
$D_1 \times A_1 \times H_1$	65.46	11.00de	7.67	42.00i	32.28de	23.87	2.98def	3.40	46.80
$D_1 \times A \times H_2$	73.22	13.33b	8.67	120.67bc	6.68hi	25.48	3.28bcd	4.32	43.28
$D_1 \times A \times H_3$	69.72	12.67bc	9.33	107.33d	13.20gh	24.82	3.58bcd	3.62	49.89
$D_1 \times A_2 \times H_1$	68.47	11.33cde	10.00	59.67h	21.11fg	25.14	2.65efg	3.65	42.41
$D_1 \times A_2 \times H_2$	71.92	14.67a	12.67	134.00a	3.84i	24.81	4.22a	4.47	48.55
$D_1 \times A_2 \times H_3$	74.42	13.33b	11.67	123.67b	9.93hi	24.74	3.84ab	4.14	48.15
$D_1 \times A_3 \times H_1$	67.80	11.67cde	8.00	37.33ij	38.15d	24.07	2.65efg	3.32	44.48
$D \times A_3 \times H_2$	69.42	11.67cde	7.67	110.67d	6.74hi	24.48	3.32bcd	3.96	45.56
$D_1 \times A_3 \times H_3$	71.62	12.33bcd	8.33	99.67e	13.82gh	25.01	2.98def	3.75	44.40
$D_2 \times A_1 \times H_1$	69.17	10.33ef	8.00	13.33k	73.08b	24.47	2.07g	3.08	40.00
$D_2 \times A_1 \times H_2$	68.44	13.67ab	9.67	85.00f	14.73gh	24.71	2.99def	3.60	45.20
$D_2 \times A_1 \times H_3$	66.88	11.67cde	7.67	68.00gh	24.74ef	25.41	3.15cde	3.67	46.29
$D_2 \times A_2 \times H_1$	64.97	9.67f	7.00	30.67ijk	46.20c	24.47	2.48fg	3.39	42.29
$D_2 \times A_2 \times H_2$	73.30	12.67bc	8.67	101.33e	11.39hi	23.81	3.70abc	4.23	46.76
$D_2 \times A_2 \times H_3$	72.77	11.67cde	8.33	93.33ef	13.82gh	25.13	3.22cde	3.48	47.98
$D_2 \times A_3 \times H_1$	64.72	9.33f	6.67	53.3hi	88.11a	24.50	1.48h	2.23	39.50
$D_2 \times A_3 \times H_2$	72.20	12.67bc	10.00	72.33g	20.80fg	24.74	3.48bcd	3.93	46.99
$D_2 \times A_3 \times H_3$	69.41	11.00de	8.33	59.00h	29.82e	24.66	3.32bcd	3.85	46.23
CV(%)	3.91	8.98	10.09	3.9	19.36	3.45	6.96	18.38	10.54
Level of Sig.	NS	*	NS	**	*	NS	**	NS	NS

In a column, values having the same letter or without letter do not differ significantly whereas values with dissimilar letter differ significantly as per DMRT. * = Significant at 5% level of probability. ** = Significant at 1% level of probability. NS = Not significant, D_1 = 40 g seeds m^{-2}, D_2 = 80 g seeds m^{-2}; A_1= 20-days old, A_2= 30-days old, and A_3= 40-days old seedling; H_1= 2 seedlings hill^{-1}, H_2= 4 seedlings hill^{-1}, and H_3= 6 seedlings hill^{-1}

Straw yield

Individually, the seeding density, age of seedlings and number of seedlings hill^{-1} had statistically significant effect on the straw yield (Table 1). The highest straw yield (3.85 t ha^{-1}, 3.89 t ha^{-1} and 4.09 t ha^{-1}) were obtained from the 40 g seed m^{-2}, 30-day old seedlings and 4 seedlings hill^{-1}, respectively (Table 1). The highest plant height and higher number of total tillers hill^{-1} were responsible for the highest straw yield. Interaction between seeding density and age of seedlings showed the significant interaction effect while other interactions were not statistically significant (Tables 1–5) which were in contribution with the findings of Sarwar *et al.* (2011). This difference could be due to differences in the variety tested their study. The highest straw yield (4.09 t ha^{-1}) was recorded in nursery seeding density of 40 g m^{-2} with 30-day old seedling (Table 2).

Harvest index

Among all the treatments and their interactions, harvest index was only influenced by the seeding density and number of seedlings hill^{-1} as well as their interactions (Table 1–5). The highest harvest index 45.95% and 47.16% were found in 40 g seed m^{-2} and 6 seedlings hill^{-1}, respectively. Yang and Zhang (2010) reported that crop management holds great promise to enhance harvest index in rice. In case of interaction, the highest harvest index (47.48%) was obtained in seeding density 40 g seed m^{-2} and 4 seedlings hill^{-1} while the lowest value (40.60%) was found in seeding density of 40 g seed m^{-2} with 2 seedlings hill^{-1} (Table 3). This trend of harvest index is in partial agreement with that of Sarwar *et al.* (2011) and Adhikari *et al.* (2013).

Conclusion

The findings of the study suggest that 30-day old seedlings raised from nursery seeding density of 40 g seed m^{-2} could be transplanted with 4 seedlings hill^{-1} to obtain the highest grain yield of short duration transplanted *Aus* rice (cv. Parija).

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