ISSN: 2518-2021 (Print), 2415-4474 (Online) Fundam Appl Agric 2017, 2(2): 233-236

Fundamental and Applied Agriculture

Journal homepage:www.f2ffoundation.org/faa

Agronomy

ORIGINAL ARTICLE

Yield and yield components of short duration transplant *Aus* rice (cv. *Parija*) as influenced by plant spacing and nitrogen level

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A R T I C L E I N F O

Article history:

Received: 28 February 2017

Received in revised form: 13 March 2017

Accepted: 05 April 2017

Available online: 01 May 2017

Academic Editor: Md. Rashedur Rahman

Keywords:

Spacing

Nitrogen level

Yield

Short duration *Aus* rice

Parija

A B S T R A C T

In our country most of the fields remain fallow after *Boro* harvest and before plantation of T. *Aman* seedling. Indigenous cultivar Parija rice cultivation is becoming popular in northern region of Bangladesh to ensure food security especially in the off season. So, optimization of agronomic practices for Parija rice cultivation is important. In this regard, an experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh from April to July 2012 to examine the effect of plant spacing and nitrogen level on the yield performance of short duration transplant *Aus* rice (cv. Parija). The experiment consisted of four spacing viz. 20 cm × 20 cm, 20 cm × 15 cm, 20 cm × 10 cm and 15 cm × 15 cm and four nitrogen levels viz. 0, 35, 70 and 105 kg N ha^{-1}. The experiment was laid out in a Randomized Complete Block Design with three replications. At harvest the tallest plant (79.39 cm) was recorded at the spacing 20 cm × 10 cm and the shortest one (74.78 cm) from 20 cm × 20 cm. The highest number of total tillers hill^{-1} (10.08), effective tillers hill^{-1} (8.31), grains panicle^{-1} (146.49), grain yield (2.36 t ha^{-1}) and straw yield (2.97 t ha^{-1}) were found at the plant spacing 20 cm × 15 cm. The lowest grain yield (1.97 t ha^{-1}) and straw yield (2.49 t ha^{-1}) were obtained from the spacing of 15 cm × 15 cm. The highest plant height (77.54 cm) at harvest was found by application of 105 kg N ha^{-1} while the shortest one (73.28 cm) from control plots (without N). The highest number of total tillers hill^{-1} (11.96), effective tillers hill^{-1} (10.39), grains panicle^{-1} (151.10), grain yield (2.95 t ha^{-1}), straw yield (3.58 t ha-1) and harvest index (45.12 %) were found when fertilized with 70 kg N ha^{-1}. The lowest number of effective tillers hill^{-1} (3.68), grains panicle^{-1} (133.83), grain yield (0.91 t ha^{-1}), straw yield (1.52 t ha^{-1}) and harvest index 37.65 % were found in control treatment. The highest number of total tillers hill^{-1} (12.52), grains panicle^{-1} (157.17), grain yield (3.41 t ha^{-1}) and straw yield (4.05 t ha^{-1}) were recorded at the spacing of 20 cm × 15 cm fertilized with 70 kg N ha^{-1} while the lowest grain yield (0.68 t ha^{-1}) was obtained from 15 cm × 15 cm spacing with control treatment. It can be concluded that short duration *Aus* rice (cv. *Parija*) can be transplanted at the 20 cm × 15 cm spacing with 70 kg N ha^{-1} to obtain maximum yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most extensively cultivated crop in Bangladesh and the staple food for her people. Rice covers about 81% of total cropped area in the country and the total rice production stands at 34.5 m. metric tons (BBS, 2016). There are three distinct growing seasons of rice namely, *Aus*, *Aman* and *Boro*in Bangladesh. The production of rice in *Aus*, *Aman* and *Boro* seasons are 2.47, 13.58 and 18.90 million tons, respectively (AIS, 2017). Both area (1.05 million ha) and yield (2.19 t ha^{-1}) of *Aus* rice were very low compared with other two seasons (BBS, 2016).

The climate and soil of Bangladesh are favourable for year round rice production but the yield of this crop is much below the potential level. The important ways of increasing yield of rice unit^{-1} area is agronomic management practices. Plant spacing is an important factor, which plays a significant role on growth,

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development, and yield of rice at its optimum level beside it, which provides scope to the plants for efficient utilization of solar radiation and nutrients (Miah et al., 1990). Closer spacing hampers intercultural operation, more competition arises among the plant for nutrient, air and light as a result plant becomes weaker and thinner, consequently reduces yield. Under wider plant spacing farmer could not get desired hill per unit area which ultimately reduces yield. Proper spacing may help to receive maximum light interceptions to enhance photosynthesis as well as yield of rice. Therefore, manipulation of spacing may lead to increase the grain yield of transplant *Aus* rice. A higher output per unit area also demands considerable amounts of external inputs, such as fertilizer. Nitrogen is the most essential macro element in determining the yield potential of rice and nitrogenous fertilizer is one of the major inputs to rice production(Mae, 1997). Excess amount of nitrogenous fertilizer results in lodging of plants, prolonging growing period, delayed in maturity and reducing yield (Uddin, 2003). Efficient fertilizer management gave higher yield of crop and reduced fertilizer cost (Hossain and Islam, 2006). Plants growth is seriously hampered when lower dose of nitrogen is applied which drastically reduces the yield. So, the selection of the most appropriate levels of nitrogen fertilizer is a major concern offering economic viability of the crop production.

Cultivation of Parija rice has been expanding in Northern part of Bangladesh every year as short duration *Aus* crop during the off season in between *Boro* and *Aman* cultivations to keep agricultural productions in an increasing trend despite adverse impacts of climate change to ensure food security. Parija rice farming enables farmers in getting an additional rice harvest from the same land during the *Aus* season after *Boro* harvest and transplantation of *Aman* seedlings between late May and mid-August. However the potential production of Parija rice depends on better agronomic management practices such as proper fertilization and planting techniques. So the present study is investigating the nitrogen fertilization issues, the effort to find out optimum spacing under different nitrogen levels as an important means to increase the *Aus* rice yield.

METHODOLOGY

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period from April to July 2012. The experiment field was located in a medium high land having sandy loam with low organic matter content and pH 6.8. The experiment comprised four spacing viz. 20 cm × 20 cm, 20 cm × 15 cm, 20 cm × 10 cm and 15 cm × 15 cm and four nitrogen levels viz. 0, 35, 70 and 105 kg N ha^{-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 indigenous variety of *Aus* rice cv. *Parija* was used in this experiment. Life duration of *Parija* rice is 90 days with an average yield 3.5 t ha^{-1}. The sprouted seeds were broadcasted uniformly in a well prepared nursery bed on 15 April, 2012. The lands were finally prepared and the plots were laid out on 4 May, 2012.In addition to nitrogen a basal dose 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 as per treatment used in the experiment in two equal splits at 10 DAT and 30 DAT. All the plots were transplanted on 5 May, 2012 maintaining 4 different plant spacing (20 cm × 20 cm, 20 cm × 15 cm, 20 cm × 10 cm and 15 cm × 15 cm) as per experimental specification using 2-3 seedlings hill$^{-1.}$ Constant water depth of 5-7 cm was maintained in the experimental field throughout the growing period. The experimental plots were irrigated and drained out as and when necessary during the growing period of the crop. The crop was found infested with some weeds and were controlled by hand weeding. To control insects, 10 kg of granular Carbofuran-5G per hectare were applied during the first top-dressed of urea; liquid insecticides were applied during the second top-dress and during the milking stage of the panicle to save the crop from stem borer and rice bug insects. 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 area) were selected randomly from each unit plot and uprooted for recording data. After sampling a harvest area of central 1m × 1m was selected from each unit plot and harvested on 29 July, 2012. 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 grain straw were recorded plot wise. The grains were cleaned and sun dried to a moisture content of 14%. Finally grain and straw yields per plot were recorded and converted to t ha-1. The harvest index was computed by using the following formula :

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

Analysis of variance was done with the help of computer package MSTAT. The mean differences among the treatments were tested with Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of plant spacing

Plant spacing significantly influenced the plant height, number of total tillers hill^{-1} number of effective tillers hill^{-1}, number of non-effective tillers hill^{-1}, grains panicle^{-1}, grain and straw yield ha^{-1}. Plant spacing did not show any significant variation in respect of 1000-grain weight (Table 1). Densely populated plants (20 cm x 10 cm) were the tallest and the shortest from sparsely populated plants. Number of total tillers hill^{-1} (10.08) and number of effective tillers hill-1(8.31) were the highest at the spacing 20 cm × 15 cm which were statistically at par with 15 cm × 15 cm. The lowest values were recorded at the spacing 20 cm × 10 cm. Number of non-effective tillers hill^{-1}(2.33) was recorded at the spacing 20 cm × 20 cm which was statistically identical with 20 cm × 10 cm and the lowest one was obtained in 20 cm × 15 cm. The highest number of grains panicle^{-1} (146.49) was obtained at the spacing 20 cm × 15cm which was statistically at par with the spacing 15 cm × 15 cm while the lowest value grains panicle-1and the highest number of sterile spikelets panicle^{-1} at the spacing 20 cm × 20cm. Higher grain yield (2.36 t ha^{-1}) and straw yield (2.97 t ha^{-1}) were obtained at the spacing20 cm × 15 cm followed by spacing 20 cm × 20cm and the lowest values were recorded at 15 cm × 15 cm. The increase in grain yield with plant spacing 20 cm × 15 cm might be attributed to higher number effective tillers hill^{-1} and grains panicle^{-1} (Table 1).

Effect of nitrogen

Plant height, number of total tillers hill^{-1}, number of effective tillers hill^{-1}, number of non-effective tillers hill^{-1}, grains

Table 1. Effect of plant spacing on the yield and yield components of transplant *Aus* rice

Plant spacing	Plant height (cm)	Total numbers of tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (HI)
20 cm × 20 cm	74.78c	9.88a	7.55b	2.33a	130.80c	22.24a	23.01	2.18b	2.77ab	4.95b	43.25
20 cm × 15 cm	69.59d	10.08a	8.31a	1.78b	146.49a	18.97b	23.13	2.36a	2.97a	5.32a	42.91
20 cm × 10 cm	79.39a	8.92b	6.80c	2.12ab	140.70b	20.13b	23.39	2.07bc	2.62ab	4.69bc	43.56
15 cm × 15 cm	78.00b	9.92a	8.19a	1.73b	144.48ab	20.48b	23.35	1.97c	2.49b	4.45c	42.99
CV(%)	2.12	7.14	9.19	14.82	2.4	8.54	2.47	6.33	5.21	2.65	2.5
Level of sig.	**	**	**	*	**	**	NS	**	**	**	NS

Mean values in a column having the same letter do not differ significantly as per DMRT
** significant at 1% level
* significant at 5% level
NS not significant

panicle^{-1}, grain, straw yield ha-1and harvest index were significantly influenced by different levels of nitrogen. Thousand-grain weight remained unaltered due to N fertilizer application (Table 2). Plant height increased gradually with the increasing rates of nitrogen at 105 kg ha^{-1} and it was found significantly higher (77.54 cm) from the other levels of nitrogen. The shortest plant (73.28 cm) was found in the control plot (without N). Nitrogen induced maximum vegetative growth with higher rates of N. Similar results were also reported by Salahuddin et al. (2009) and Jisan et al. (2014). The highest numbers of total tillers hill^{-1}(11.96) and number of effective tillers hill^{-1} (10.39)were obtained when fertilized with 70 kg N ha^{-1}while the lowest values were recorded in control. The highest number of grains panicle^{-1} (151.10) was obtained at 70 kg ha^{-1}, which was significantly different from other N levels. The lowest number of grains panicle^{-1} (133.83) and maximum sterile spikelets panicle^{-1} were obtained from control (0 kg N ha^{-1}). Nitrogen helped in proper filling of seeds which resulted higher produced plump seeds and thus the number of grains panicle^{-1}.

Grain yield of short duration *Aus* rice increased gradually with the increasing levels of nitrogen upto 70 kg N ha^{-1}, but at higher rates (105 kg ha^{-1}), grain yield tended to decrease. The highest grain yield (2.95 t ha^{-1}) was obtained at 70 kg N ha^{-1}and the lowest (0.91 t ha^{-1}) in control (0 kg N ha^{-1}). Similar trend was also observed elsewhere (Salahuddin et al. 2009; Kirttania et al. 2013 and Haider et al. 1988). The yield difference between the highest and the lowest yielding treatments was 224%. The yield advantage of N application upto 70 kg ha^{-1} was mainly due to cumulative effect of the highest number of effective tillers hill^{-1} and grains panicle-1obtained from the supply of nitrogen for the plants. Straw yield showed the (3.58 t ha^{-1}) similar trend as grain yield. The maximum number of total tillers hill-1might be responsible for higher straw yield (3.58 t ha^{-1}) at 70 kg N ha^{-1}. Maximum harvest index (45.15%) was recorded at 35 kg N ha^{-1} which was statistically identical with 70 kg N ha^{-1} and lowest one was obtained at control (Table 2). Harvest index varied significantly with different nitrogen levels was reported elsewhere (Kirttania et al. 2013; Jisan et al. 2014 and Ray et al. 2015).

Table 2. Effect of nitrogen levels on the yield and yield components of transplant *Aus* rice

Nitrogen level (kg ha^{-1})	Plant height (cm)	Total numbers of tillers hill^{-1}	Number of effective tillers hill^{-1}	Number of non-effective tillers hill^{-1}	Number of grains panicle^{-1}	Number of sterile spikelets panicle^{-1}	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (HI)
0	73.28c	6.18d	3.68d	2.50a	133.83d	27.37a	23.48	0.91d	1.52d	2.43d	37.65c
35	75.49b	9.60c	7.07c	2.52a	136.11c	21.92b	23.08	2.25c	2.73c	4.97c	45.15a
70	75.44b	11.96a	10.39a	1.56b	151.10a	14.59d	23.03	2.95a	3.58a	6.53a	45.12a
105	77.54a	11.08b	9.70b	1.38b	141.43b	17.95c	23.28	2.46b	3.02b	5.49b	44.80b
CV(%)	2.12	7.14	9.19	14.82	2.4	8.54	2.47	6.33	5.21	2.65	2.5
Level of sig.	**	**	**	**	**	**	NS	**	**	**	**

Mean values in a column having the same letter do not differ significantly as per DMRT
** significant at 1% level
NS not significant

Interaction effect between plant spacing and nitrogen level

Interaction of plant spacing and nitrogen levels showed significant effect on plant height, number of total tillers hill^{-1}, number of effective tillers hill^{-1}, number of non-effective tillers hill^{-1}, grains panicle^{-1}, grain and straw yield (Table 3). The tallest plant (81.17 cm) was recorded at spacing 20 cm × 20 cm fertilized with 35 kg N ha-1 while plants grown at any plant spacing without N fertilization produced shortest plant. Number of total tillers hill-1(12.81) and number of effective tillers hill^{-1}(11.83) were the highest at spacing 15 cm × 15 cm with 70 kg N ha^{-1}which were statistically at par with 20 cm × 15 cm with 70 kg N ha^{-1}, and maximum non-effective tillers (3.47) were recorded in15 cm × 15 cm with 35 kg N ha^{-1} which were statistically at par with 20 cm × 20 cm with 0 kg N ha^{-1}. The maximum number of grains panicle (160.65) obtained by the treatment combination 15 cm × 15 cm spacing with 70 kg N ha^{-1}, which was as good as 20 cm × 15 cm spacing with 70 kg N ha-1 whereas the lowest number of grains panicle-1 was given by 0 kg N ha-1with plant spacing 20 cm × 20 cm. The highest number of sterile spikelets panicle^{-1} was given by 0 kg N ha-1 irrespective of plant spacing. Grain yield ha^{-1} increased with increasing level of nitrogen upto 70 kg ha^{-1} irrespective of plant spacing. The spacing 20 cm × 15 cm accompanied with 70 kg N ha^{-1} gave the highest yield (3.41 t ha^{-1}) and straw yield (4.05 t ha^{-1}), but it was statistically at par those of N dose with 20 cm × 20 cm spacing while grain and straw yields were the lowest in control N treatment irrespective of plant spacing (Table 3).

Table 3. Interaction effect of plant spacing and nitrogen levels on the yield and yield components of transplant *Aus* rice

Plant spacing	N level (kg N ha^{-1})	Plant height (cm)	Total number of tillers $hill^{-1}$	Number of effective tillers $hill^{-1}$	Number of non-effective tillers $hill^{-1}$	Number of grains $panicle^{-1}$	Number of sterile spikelets $panicle^{-1}$	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (HI)
20 cm × 20 cm	0	70.65e	6.79g	3.50i	3.30a	122.71g	28.56ab	23.32	1.00gh	1.76f	2.75f	37.58
	35	73.65d	9.68e	7.38fg	2.30bc	132.72f	22.74de	23.00	2.15ef	2.60e	4.75e	45.24
	70	76.13cd	11.26bc	9.19cd	2.07bcd	125.60g	20.48efg	22.90	3.15ab	3.86a	7.00a	44.84
	105	78.67ac	11.81ab	10.13bc	1.67b-e	142.18bcd	17.17hi	22.80	2.41def	2.88cde	5.29cde	45.31
20 cm × 15 cm	0	69.08e	5.91g	3.76i	2.16bc	135.13ef	29.57a	23.43	0.89gh	1.63f	2.52f	35.42
	35	69.72e	10.71b-e	8.69de	2.02bcd	145.95bc	18.54gh	22.77	2.52de	3.04bcd	5.56cd	45.32
	70	69.79e	12.52a	10.78ab	1.74b-e	157.17a	12.70jk	22.76	3.41a	4.05a	7.46a	45.73
	105	69.79e	11.19bcd	10.00bc	1.19def	147.69b	15.08ij	23.56	2.60cd	3.15bc	5.75bc	45.18
20 cm × 10 cm	0	77.58c	6.38g	3.75i	2.63ab	137.28def	25.03cd	23.51	1.06g	1.55f	2.61f	40.54
	35	81.17a	8.04f	5.74h	2.30bc	132.61f	22.14def	23.53	2.13f	2.68de	4.81e	44.26
	70	78.18bc	11.23bc	9.77bcd	1.46cde	160.65a	14.03jk	23.14	2.93bc	3.37b	6.30b	46.55
	105	80.63ab	10.03cde	7.93ef	2.10bcd	132.26f	19.32fgh	23.36	2.17ef	2.89cde	5.06de	42.89
15 cm × 15 cm	0	75.81cd	5.63g	3.71i	1.93bcd	140.20cde	26.31bc	23.67	0.68h	1.15g	1.83g	37.05
	35	77.44c	9.95de	6.48gh	3.47a	133.17f	24.24cd	23.02	2.18ef	2.59e	4.77e	45.76
	70	77.68c	12.81a	11.83a	0.99ef	160.99a	11.13k	23.31	2.33def	3.04bcd	5.37cde	43.35
	105	81.07ab	11.29bc	10.73ab	0.55f	143.57bc	20.23e-h	23.38	2.67cd	3.16bc	5.84bc	45.80
CV(%)		2.12	7.14	9.19	14.82	2.40	8.54	2.47	6.33	5.21	2.65	2.5
Level of sig.		**	**	**	**	**	**	NS	**	**	**	NS

Mean values in a column having the same letter do not differ significantly as per DMRT
** significant at 1% level
NS not significant

CONCLUSION

The highest grain and straw yields were recorded at the spacing of 20 cm × 15 cm fertilized with 70 kg N ha^{-1} while the lowest grain yield was obtained from 15 cm × 15 cm spacing with control treatment (0 kg N ha^{-1}). From the results, it can be concluded that transplant *Aus* rice cv. *Parija* grown under 20 cm × 15 cm spacing with 70 kg N ha^{-1} emerged out as a promising practice to achieve desired grain yield.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

REFERENCES

AIS (Agricultural Information Service). 2017. Krishi Diary. Agril. Inf. Ser. Dhaka. p.17.

BBS (Bangladesh Bureau of Statistics). 2016. The Yearbook of Agricultural Statistics of Bangladesh. Stat. Div., Minis. Plan, Govt. People's Repub., Bangladesh, Dhaka. 37p.

FAO (Food and Agriculture Organization). 2009. Production Year Book. Food and Agric. Organ of the United Nations, Rome. 45: 72-73.

Gomez KA, Gomez AA. 1984. Statistical Procedure for Agricultural Research Intl. Rice Res. Inst., John Wiley and Sons.New York, Chickester, brisbane, Toronto, Singapore. pp. 1-34.

Haider MR, Ali MI, Zaman SM, Islam AFSM. 1988. Yield and Yield attributes of rice as affected by N, P, K, S, and Zn fertilization. Bangladesh J. Nuclear Agric. 4: 61-68.

Hossain SMA, Islam MS. 2006. Fertilizer Management in Bangladesh. Adv. Agron. Res. Inst., Joydebpur, Gazipur. pp. 48-54.

Jisan MT, Paul SK, Salim M. 2014. Yield performance of some transplant *Aman* rice varieties as influenced by different levels of nitrogen. J. Bangladesh Agril. Univ., 12 (2): 321-324.

Kirttania B, Sarkar MAR, Paul SK. 2013. Performance of transplant *Aman* rice as influenced by tiller seedlings and nitrogen management. J. Bangladesh Agril. Univ., 11 (2): 249-256.

Mae T. 1997. Physiological nitrogen efficiency in rice. Nitrogen utilization photosynthesis and yield potential. In plant nutrition for sustainable food production and environment. Ando

T., K. Fujita, T. Mae. H. Matsumota, S. Mori and J. Sekiya (eds). Kluwer Academic Publishers Printed in Japan. 51-60.

Ray S, Sarkar MAR, Paul SK, Islam AKMM, Yeasmin S. 2015. Variation of growth, yield and protein content of transplant *Aman* rice by three agronomic practices. Agricultural and Biological Sciences Journal. 1 (4): 167-176.

Uddin MH. 2003. Effect of plant spacing and nitrogen levels on yield of transplanted *Aman* rice cv. BR39. M. S. Thesis, Dept. Agron. Bangladesh Agril. Univ., Mymensingh. pp. 16-44.