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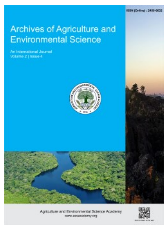

ORIGINAL RESEARCH ARTICLE

Effect of age of seedlings at staggered planting and nutrient management on the growth performance of aromatic fine rice (*Oryza sativa* L. cv. BRRI dhan38)

Anup Roy, Md. Abdur Rahman Sarkar, Afrina Rahman and Swapan Kumar Paul*

Department of Agronomy, Bangladesh Agricultural University, Mymensingh - 2202, BANGLADESH
*Corresponding author's E-mail: skpaul@bau.edu.bd

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ABSTRACT

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during June to December 2014 with a view to finding out the effect of age of seedlings at staggered planting and nutrient management on growth of aromatic fine rice (cv. BRRI dhan38). The experiment comprised three ages of seedlings *viz.*, 30, 45 and 60-day old and six treatment of nutrient managements *viz.* control (no manures and fertilizers), recommended dose of inorganic fertilizers, 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} and 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The effect of age of seedlings and nutrient management and their interaction were significant on crop growth characters of aromatic fine rice. The result revealed that the highest plant height, total tiller hill^{-1}, total dry matter production hill^{-1} and CGR were found when 30-day old seedlings were transplanted. Among the nutrient managements the highest growth parameters was obtain in 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} due to the continuous supply of nutrients by the combination of organic and inorganic fertilizer which led to better growth in plants. In 30-day old seedlings with 75% inorganic fertilizer + poultry manure @ 2.5 t ha^{-1} treatment performed best in case of all growth parameters, while the lowest one was observed in 60-day old seedlings with control. Therefore, 30-day old seedlings with 75% inorganic fertilizer + poultry manure @ 2.5 t ha^{-1} treatment might be a promising practice in aromatic fine rice cultivation in terms of growth performance.

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INTRODUCTION

Rice (*Oryza sativa* L.) is one of the principal food crops of the world in respect of economic and social significance. It is the staple food for more than half of the world population and grows in more than 100 countries (Meral and Erturk, 2017). Rice production has been given the highest priority in meeting the demand of the ever-increasing population in Bangladesh. The area and production of rice in Bangladesh is about 11.01 million hectares and 33.80 million tons, respectively (BBS, 2018). *Aman* rice covers 49.12% of rice growing area in Bangladesh with 13.48 million tons of production (BBS, 2018) and aromatic rice constitutes 12.50 % of the total transplanted *Aman* rice (Roy *et al.*, 2018). This aromatic rice has greater potential to attract consumer for its taste, higher price and low cost of cultivation compared to other non-aromatic rice. The demands of aromatic rice for internal consumption and for export are increasing day by day (Das and Baqui, 2000) and it has the capacity to boost up the economic condition of the rice grower in the developing countries. In Bangladesh, a number of fine rice cultivars are grown by the farmers *viz.*, Chinisagar, Badshabhog, Kataribhog, Kalizira, Tulsimla, Dulabhog, Basmati, Banglamati (BRRI dhan50), BRRI dhan34, BRRI dhan37, BRRI dhan38, Binadhan-9 and Binadhan-13. But majority of the aromatic rice cultivars are low yielding compared to coarse and medium rice (Sinha *et al.* 2018). Besides the genetic constituents of aromatic rice varieties, different management practices could be responsible for this low yield.

The age of seedlings at transplanting is important because it contributes to the number of tiller production hill^{-1} and uniform stand establishment of rice (Ginigaddara and Ranamukhaarachchi (2011). In Bangladesh, sometimes transplanting of *Aman* rice is delayed due to unavailability of seedlings and late recession of flood water and as a result, farmers cannot transplant *Aman* rice at optimum date. In such cases more seedlings can be raised in the nursery bed which can be transplanted in the main field at a later date than the optimum one so that, the damaged caused by the floods can be minimized. The use of seedlings from the same source of planting at optimum date thereafter, at different dates are termed as staggered planting of rice seedlings having different ages. Judicious use of fertilizers and proper age of seedlings improves the growth of aromatic rice (Pramanik and Bera, 2013). Optimum age of seedlings supports the plants to uptake more nutrients from the soil. Almost all soils of Bangladesh are deficient in nitrogen mainly due to low level of organic matter caused by continuous intensive cropping with high yielding varieties and adding of less amount of organic matter. Use of fertilizer is an essential component of modern farming but many research findings have shown that neither inorganic nor organic source can alone result in sustainable productivity (Parihar *et al.*, 2015).

Plants respond differently to mix use of NPK chemical fertilizer and livestock organic manure at different growth stages (Chand *et al.*, 2006). Few efforts have taken to address the synergistic influence of seedling age and nutrient management on the plant growth and physiological responses of aromatic rice (Thapa *et al.*, 2014). Such information is vital for identifying the physiological and morphological traits to support the selection of sustainable seedling age and nutrient management. Therefore, keeping these points in view, the present investigation was undertaken to evaluate the comparative effects of different seedling age at staggered planting and nutrient management on the growth performance of aromatic rice cultivar (cv. BRRI dhan38).

MATERIALS AND METHODS

Experimental design and treatments

The experiment was conducted at the Agronomy Field Laboratory (24° 75' N latitude and 90° 50' E longitude and at an altitude of 18 meter above the sea level), of Bangladesh Agricultural University, Mymensingh in the *Aman* (rainy) season during June to December 2014. The experimental site belongs to the Sonatola series of the dark grey floodplain soil type under Old Brahmaputra Floodplain Agro-Ecological Zone (AEZ-9). The field was a medium high land with well drained silty-loam texture having pH value 6.5 and 1.29% organic matter content. Aromatic rice variety BRRI dhan38 was used as plant material. The experiment comprised three ages of seedlings *viz*. 30, 45 and 60-day old and six treatment of nutrient managements *viz*. control (no manures and fertilizers), recommended dose of inorganic fertilizers (i.e. 150, 97, 70, 60 and 12 kg ha^{-1}of Urea, TSP, MoP, Gypsum and $ZnSO_4$, respectively) (FRG, 2012), 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} and 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The size of unit plot was 4.0 m × 2.5 m (10 m^2). The distances between blocks and plots were 1.0 m and 75 cm, respectively. Sprouted seeds were sown in the prepared wet nursery bed on 23 June 2014. The main field was prepared by power tiller with three times ploughing and cross ploughing followed by laddering. The land was fertilized as per treatment specifications. At the time of final land preparation, respective unit plots were fertilized with specified amount of cowdung, poultry manure, triple superphosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate. Urea was applied in three equal splits at 15, 30 and 45 days after transplanting (DAT).

Transplantation of seedlings and cultivation practices

Seedlings were transplanted on the well puddled experimental plots following staggering of transplanting on 23 July, 8 August and 23 August 2014, maintaining the spacing of 25 cm × 15 cm using three seedlings hill^{-1}. Intercultural operations were done for ensuring and maintaining the vigorous growth of the crop. Intensive care was taken throughout the growing season.

Collection of data

Growth parameter such as plant height, number of tillers hill^{-1}, total dry matter (TDM) production hill^{-1}etc. were determined at 15, 30, 45 and 60 DAT. Five hills (excluding border hills) were selected randomly from each plot and marked by bamboo stick to collect data on plant height and tiller number. Plant height was measured with the tallest tiller from the selected hills which gave the average plant height. For each destructive sample, five hills were uprooted excluding the border rows and central harvest area. Samples were washed with water, de-rooted and leaves were separated from the culms. Then the plant samples were dried in an electric oven for 72 hour until they reached at constant weight, and their dry weights were recorded. CGR was calculated following the standard formulae (Radford, 1967; Hunt, 1978).

Statistical analysis

The collected data were compiled and tabulated in proper from and subjected to statistical analysis. The recorded data were analyzed following analysis of variance technique and mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect of seedling age at staggered planting

Plant height, tillers hill^{-1} and total dry matter production hill^{-1} showed substantial differences by seedling age at staggered planting at all dates of sampling (Table 1 and Figure 1). The highest plant height (36.19, 54.54, 71.97 and 87.25, respectively) was obtained in 30-day old seedlings and the lowest plant height (27.58, 42.35, 57.45 and 67.62, respectively) was recorded in 60 -day old seedlings at 15, 30, 45 and 60 DAT. This might be due to the availability of longer growth period with optimum photoperiod and temperature leading towards better capacity to withstand transplanting shock which ultimately increased the plant height. Gurjar *et al*. (2017) also found that in younger seedlings had better plant height compared to the older ones.

The maximum number of tillers hill^{-1} was obtained at all sampling dates when 30-day old seedlings were transplanted and the minimum number of tillers hill^{-1} was obtained at all sampling dates when 60-day old seedlings were transplanted. Number of tillers hill^{-1} was gradually increased up to 45 DAT but decreased at 60 DAT in all seedling ages irrespective of younger or older ones. This trend was also observed by Roy and Paul (2018). The tillers might be higher in early planting due to the better development of early formed tillers hill^{-1} and internal mechanism of the plant to produce the maximum number of effective tillers hill^{-1} by eliminating the non-vigorous tillers while in case of late planting, less availability of sufficient amount of photosynthates as source of energy might result this. The highest total dry matter production was obtained at all sampling dates when 30-day old seedlings were transplanted and the lowest total dry matter production were obtained at all sampling dates when 60-day old seedlings were transplanted. Total dry matter gradually increased with the increase of time in all cases irrespective of the age of seedling whether it is young or old (Ali *et al*., 2013). This might be due to the gradual accumulation of food material produced by plant with the help of chlorophyll using solar radiation. Crop growth rate was significantly affected by seedling age at staggered planting during the period of 15-30, 30-45 and 45-60 days after transplanting (DAT) (Figure 2). The highest crop growth rate was observed during all sampling periods when 30-day old seedlings were transplanted and the lowest crop growth rate was obtained at all sampling dates when 60-day old seedlings were transplanted. Crop growth rate of all ages of seedlings attained the peak within the period of 30-45 DAT. Similar trend was observed by Hossain *et al*. (2011). Wilson and Ellis (1981) also reported that crop growth rate reached the maximum at panicle emergence and decreased soon after.

Table 1. Effect of seedling age at staggered planting on number of tillers hill^{-1} and total dry matter hill^{-1}.

Age of seedling (days)	Number of tillers hill^{-1}				Total dry matter hill^{-1} (g)			
	Days after transplanting (DAT)				Days after transplanting (DAT)			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
30	4.94a	8.77a	10.89a	9.49a	3.44a	8.25a	15.43a	29.80a
45	4.91a	7.28b	8.98b	8.67b	3.22b	6.25b	12.87b	24.96b
60	3.49b	6.74c	7.32c	5.75c	2.93c	5.63c	10.81c	21.58c
$S\bar{x}$	0.067	0.085	0.127	0.087	0.033	0.056	0.112	0.332
Level of significance	**	**	**	**	**	**	**	**
CV (%)	6.44	4.58	5.56	4.45	4.39	3.51	3.64	5.54

In a column figures having common letter(s) do not differ significantly as per DMRT.

Table 2. Effect of nutrient management on number of tillers hill^{-1} and total dry matter hill^{-1}.

Nutrient management	Number of tillers hill^{-1}				Total dry matter hill^{-1} (g)			
	Days after transplanting (DAT)				Days after transplanting (DAT)			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
F_0	3.70e	5.85f	7.19f	5.93f	2.90d	5.63e	11.26e	21.40e
F_1	4.30cd	7.38d	9.06d	8.07d	3.09c	6.31d	12.41d	24.89c
F_2	4.56bc	8.28c	10.29c	8.68c	3.25b	6.87c	13.51c	26.21c
F_3	4.80b	9.19b	11.26b	9.53b	3.41a	7.46b	14.19b	27.57b
F_4	4.15d	6.94e	8.31e	7.04e	3.00cd	6.12d	12.01d	23.42d
F_5	5.17a	9.94a	12.27a	10.58a	3.54a	7.88a	14.83a	29.17a
$S\bar{x}$	0.095	0.121	0.180	0.123	0.047	0.079	0.158	0.469
Level of significance	**	**	**	**	**	**	**	**
CV (%)	6.44	4.58	5.56	4.45	4.39	3.51	3.64	5.54

In a column figures having common letter(s) do not differ significantly as per DMRT; F_0 = Control (no manures and fertilizers), F_1 = Recommended dose of inorganic fertilizers, F_2 = 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_3 = 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_4 = 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}, F_5 = 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}.

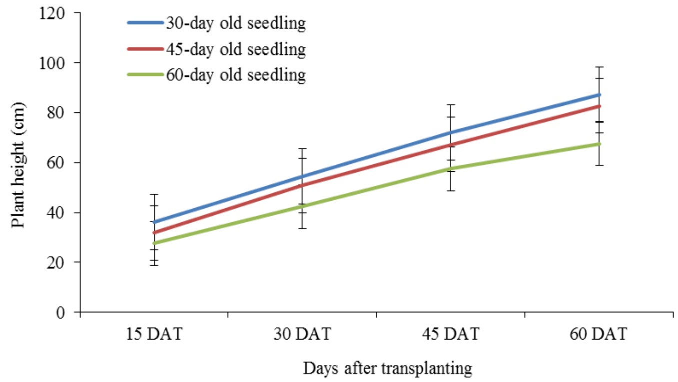

Figure 1. *Plant height influenced by seedling age at staggered planting.*

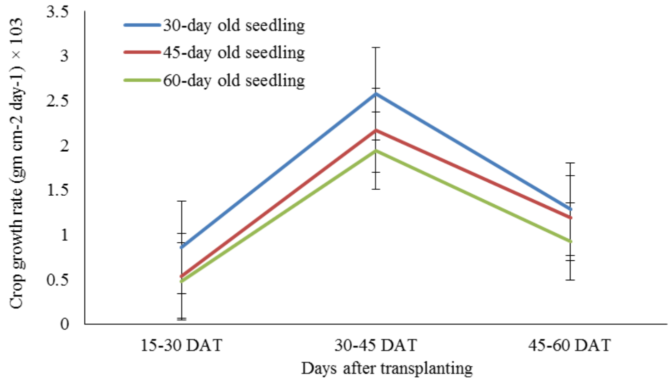

Figure 2. *CGR influenced by seedling age at staggered planting.*

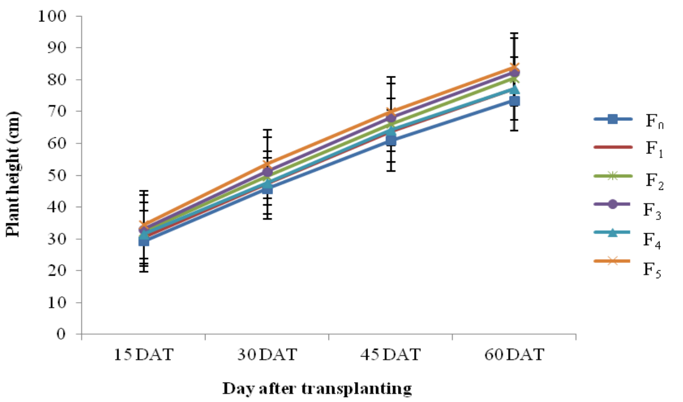

Figure 3. *Plant height influenced by nutrient management.*
F_0 = Control (no manures and fertilizers), F_1 = Recommended dose of inorganic fertilizers, F_2 = 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_3 = 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_4 = 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}, F_5 = 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}.

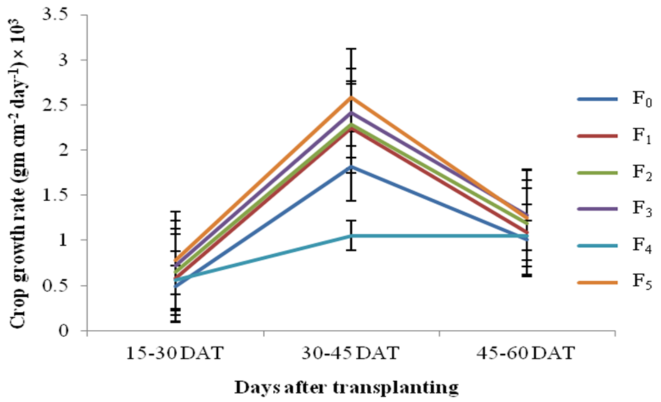

Figure 4. *CGR influenced by nutrient management.*
F_0 = Control (no manures and fertilizers), F_1 = Recommended dose of inorganic fertilizers, F_2 = 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_3 = 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_4 = 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}, F_5 = 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}.

Effect of nutrient management

Different nutrient management exerted significant effect on plant height, tiller production hill^{-1}, total dry matter production hill^{-1} and crop growth rate (CGR) at all the date of measurement. The plant height increased progressively with the advancement of time and growth stages (Figure 3). It was observed that treatment 75% inorganic fertilizer + poultry manure @ 2.5 ha^{-1} produced the tallest plant followed by 75% inorganic fertilizer + cowdung @ 5 t ha^{-1}, 50% inorganic fertilizer + cowdung @ 5 t ha^{-1}, 50% inorganic fertilizer + poultry manure @ 2.5 t ha^{-1} respectively. The shortest plant height was obtained from control. This trend of plant stature was observed at all the sampling dates. This result might be due to the fact that combined application of organic and inorganic fertilizer resulted in more nitrogen absorption for the synthesis of protoplasm which is responsible for rapid cell division which may increase the plant in shape and size. The results showed that treatment 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} produced the highest number of tillers hill^{-1} and treatment control produced the lowest number of tillers hill^{-1} at all the dates of measurement (Table 2). The number of tillers hill^{-1} increased with increasing days after transplanting due to application of different levels of fertilizers and manures up to 45 DAT. This might be due to the supremacy of the combination of organic and inorganic fertilizer which lies in the fact that it can supply the nutrients in soluble form for a quite longer period by not allowing the entire nutrient into solution which minimizes fixation and precipitation. So, integrated nutrient management might allow the plant roots to compete with loss mechanisms and absorb more nutrients leading to the highest tillers hill^{-1}. This result was in agreement with that of Marzia (2015) and Jahan *et al.* (2017) who reported that combined application of manure with 75% of recommended dose of inorganic fertilizers produced maximum number of tiller hill^{-1}. Dry weight of plant increased with increasing rates of combine fertilization. The highest total dry matter (29.17 g hill^{-1}) was obtained with the application of 75% inorganic fertilizers with poultry manure @ 2.5 t ha^{-1} at 60 DAT. The lowest dry matter production hill^{-1} was recorded in control at all sampling date and it was recorded 21.40 g at 60 DAT. Fageria and Baligar (2011) also reported that dry matter production increased with the advancement of plant age up to flowering. This significantly higher dry matter accumulation might be due to the beneficial effects of combination of inorganic and animal originated manures which might have provide higher nutrient uptake which resulted in the greater source accumulation and efficient translocation of photosynthates into the sink. Maximum CGR (2.58 g m^{-2}day^{-1}) was obtained from nutrient management 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}at 30-45 DAT while the lowest CGR (1.82 g m^{-2}day^{-1}) was found in control treatment (Figure 4). Application of inorganic fertilizers along with poultry manure might have increased the nutrient availability in the soil and their uptake by plants resulting in higher CGR.

Table 3. Effect of interaction between seedling age at staggered planting and nutrient management on plant height and tillers hill^{-1}.

Interaction (Age of seedlings × Nutrient management)	Plant height (cm)				Number of tillers hill^{-1}			
	Days after transplanting (DAT)				Days after transplanting (DAT)			
	15 DAT	30 DAT	45 DAT	60 DAT	15 DAT	30 DAT	45 DAT	60 DAT
$A_1 \times F_0$	35.28abc	53.47bcd	69.18cd	82.33	4.53	7.33fg	8.37	7.04i
$A_1 \times F_1$	35.87abc	53.85bcd	71.07bc	87.25	4.72	8.11de	9.94	9.28fg
$A_1 \times F_2$	36.10ab	54.69abc	71.78bc	88.78	4.93	9.07c	11.4	9.75ef
$A_1 \times F_3$	36.61ab	55.78ab	73.46ab	89.00	5.07	9.70b	12.6	10.52cd
$A_1 \times F_4$	35.78abc	52.70cde	70.76bcd	85.94	4.66	7.92ef	9.28	8.07h
$A_1 \times F_5$	37.51a	56.77a	75.55a	90.16	5.76	10.57a	13.7	12.30a
$A_2 \times F_0$	29.18ghi	47.23gh	62.84g	77.34	4.12	6.15h	8.60	7.417i
$A_2 \times F_1$	31.11efg	50.05ef	67.14def	82.11	4.91	7.83efg	10.4	9.35efg
$A_2 \times F_2$	32.63def	51.72def	68.19cde	84.30	5.07	8.61cd	11.7	9.97de
$A_2 \times F_3$	33.47cde	52.51cde	69.15cd	85.60	5.22	9.73b	12.3	11.0bc
$A_2 \times F_4$	30.79fgh	49.43fg	65.40efg	80.44	4.73	7.20g	9.51	8.85g
$A_2 \times F_5$	34.75bcd	54.42abcd	70.92bcd	86.52	5.41	10.18ab	13.1	11.40b
$A_3 \times F_0$	23.46j	36.67k	51.02j	61.10	2.45	4.083i	4.60	3.34m
$A_3 \times F_1$	25.06j	38.43jk	52.82j	62.72	3.28	6.21h	6.76	5.58k
$A_3 \times F_2$	28.38hi	42.87i	58.68hi	68.44	3.69	7.22g	7.75	6.32j
$A_3 \times F_3$	29.15ghi	45.66h	61.98gh	72.76	4.11	8.16de	8.76	7.05i
$A_3 \times F_4$	28.06i	40.95ij	56.40i	65.28	3.06	5.69h	6.14	4.20l
$A_3 \times F_5$	31.35efg	49.50fg	63.83fg	75.40	4.34	9.07c	9.89	8.04h
$S\bar{x}$	0.783	0.898	1.18	1.78	0.165	0.210	0.312	0.212
Level of significance	*	**	*	NS	NS	**	NS	*
CV (%)	4.25	3.16	3.11	3.89	6.44	4.58	5.56	4.45

In a column figures having common letter(s) do not differ significantly as per DMRT; NS= Not significant, F_0 = Control (no manures and fertilizers), F_1 = Recommended dose of inorganic fertilizers, F_2 = 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_3 = 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_4 = 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}, F_5 = 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}.

Table 4. Effect of interaction between seedling age at staggered planting and nutrient management on total dry matter and crop growth rate.

Interaction (Age of seedlings × Nutrient management)	Total dry matter hill^{-1} (g)				Crop growth rate (gm cm^{-2} day^{-1}) × 10^{3}		
	Days after transplanting (DAT)				Days after transplanting (DAT)		
	15 DAT	30 DAT	45 DAT	60 DAT	15-30 DAT	30-45 DAT	45-60 DAT
$A_1 \times F_0$	3.06efg	7.88c	14.78cd	27.85bc	0.87ab	1.82e	1.24abc
$A_1 \times F_1$	3.24de	8.13bc	15.20bcd	29.81ab	0.87ab	2.24c	1.27ab
$A_1 \times F_2$	3.55bc	8.19bc	15.50abc	30.04ab	0.83abc	2.28c	1.31a
$A_1 \times F_3$	3.80ab	8.38b	15.90ab	30.40ab	0.82abc	2.41b	1.35a
$A_1 \times F_4$	3.10efg	8.08bc	15.10bcd	29.41ab	0.90a	2.05d	1.26ab
$A_1 \times F_5$	3.91a	8.85a	16.08a	31.28a	0.90a	2.58a	1.30a
$A_2 \times F_0$	2.97efg	4.83g	10.11g	19.20gh	0.33gh	1.82e	0.95ef
$A_2 \times F_1$	3.09efg	5.39f	12.15f	24.25de	0.41f	2.24c	1.21abc
$A_2 \times F_2$	3.19def	6.32de	13.73e	26.40cd	0.56e	2.28c	1.33a
$A_2 \times F_3$	3.39cd	7.78c	14.58d	28.13bc	0.78c	2.41b	1.22abc
$A_2 \times F_4$	3.05efg	5.10fg	11.34f	22.13ef	0.37fg	2.05d	1.12cd
$A_2 \times F_5$	3.61bc	8.07bc	15.30abcd	29.63ab	0.80bc	2.57a	1.30a
$A_3 \times F_0$	2.68h	4.17h	8.883h	17.16h	0.26h	1.82e	0.79g
$A_3 \times F_1$	2.95fg	5.43f	9.880g	20.61fg	0.44f	2.24c	0.80g
$A_3 \times F_2$	3.00efg	6.10e	11.31f	22.20ef	0.55e	0.93ef	1.05de
$A_3 \times F_3$	3.05efg	6.23e	12.08f	24.19de	0.57e	2.41b	2.28c
$A_3 \times F_4$	2.84gh	5.18fg	9.580gh	18.73gh	0.42f	2.05d	0.85fg
$A_3 \times F_5$	3.10efg	6.71d	13.10e	26.59cd	0.65d	2.57a	1.14bcd
$S\bar{x}$	0.082	0.137	0.274	0.812	0.026	0.039	0.041
Level of significance	*	**	**	**	**	**	**
CV (%)	4.39	3.51	3.64	5.54	7.58	5.34	6.43

In a column figures having common letter(s) do not differ significantly as per DMRT; NS= Not significant, F_0 = Control (no manures and fertilizers), F_1 = Recommended dose of inorganic fertilizers, F_2 = 50% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_3 = 75% of recommended dose of inorganic fertilizers + cowdung @ 5 t ha^{-1}, F_4 = 50% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}, F_5 = 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1}.

Effects of interaction

Plant height was significantly affected by the interaction between age of seedlings at staggered planting and nutrient management at 15, 30 and 45 DAT except 60 DAT (Table 3). At 45 DAT, the tallest plant stature (75.55 cm) was observed in 30-day of seedlings × 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} and the shortest plant stature (51.02 cm) was in 60-day old seedlings × no application of manures and fertilizers. Number of tillers $hill^{-1}$ was significantly influenced by the interaction between ages of seedlings at staggered planting and nutrient management at 30 and 60 DAT (Table 3). But, at all sampling dates, the maximum number of tillers $hill^{-1}$ was obtained in 30-day old seedlings with 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} treatment. Irrespective of treatment combination tillers hill-1 increased upto 45 DAT and thereafter decreased. There was significant interaction effect between age of seedlings at staggered planting and nutrient management at all dates of sampling in case of dry matter production and CGR (Table 4). At 60 DAT, the highest dry matter production $hill^{-1}$ (31.28 g) was recorded in 30-day old seedlings × 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} and lowest (17.16 g) was recorded in 60-days old seedlings × control. During all periods, the highest crop growth rate was recorded in 30-day old seedlings with 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} and the lowest crop growth rate was obtained by 60-day old seedlings with control treatment (Table 4). Plant height, tillers $hill^{-1}$, TDM and CGR were increased by using younger seedlings with combination of organic and inorganic fertilizer (Rahman *et al*., 2013; Hasanuzzaman *et al*., 2014 and Singh *et al*., 2017.

Conclusion

The effect of age of seedlings at staggered planting and nutrient management and their interaction were significant on crop growth of aromatic fine rice. The highest plant height, tiller $hill^{-1}$, dry matter and CGR were recorded in 30-day old seedlings. In case of nutrient management, 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} produced the highest growth parameters. In interaction, 30-day old seedlings with 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} produced the highest value in case of all growth characters. Therefore, 30-day old seedlings fertilized with 75% of recommended dose of inorganic fertilizers + poultry manure @ 2.5 t ha^{-1} appeared as the promising technique for proper growth of aromatic fine rice (cv. BRRI dhan38).

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