Original Research Article

Effect of Seedling Age on Growth and Yield of Local Aman Rice Varieties in the Low Land Area of Southwestern Coastal Bangladesh

Abstract

Suitable variety and optimum seedling age are important agronomic decisions for better productivity of rice particularly in the low land area. A field experiment was conducted at the experiment field of Agrotechnology Discipline, Khulna University, Khulna, Bangladesh during *aman* season (monsoon) to investigate the effect of seedling age on growth, yield attributes and yield of different local *aman* rice varieties in the coastal low land area of southwestern Bangladesh. Four different seedling ages (15, 30, 45 and 60-days old) and three local rice varieties (Ranisalute, Jatai balam and Basful balam) were used as experimental treatments. The experiment was arranged in a factorial randomized complete block design and replicated thrice. Earlier age seedling (15 days) substantially influenced the growth parameters but yield attributes and yield were significantly higher with 30-days old seedlings yet no significant variation with 45-days old seedling. 30-days old seedling produced 8-32% more grain yield than other seedling ages. Among the varieties, the highest plant height, yield components and yield were achieved from Ranisalute yet the yield variation was only 3-5%. From the findings of this experiment, it can be concluded that Ranisalute variety with the use of 30-days old seedling is better for low land area of southwestern coastal Bangladesh.

Keywords: *Seedling age, Variety, Yield, Low land area, Coastal region*

Introduction

Rice (*Oryza sativa* L.) is one of the major and most extensively cultivated cereal crops of the world including Bangladesh that feeds half of the total world population as a staple food [1]. Agriculture in Bangladesh is characterized by intensive crop production with the rice-based cropping system. In Bangladesh, rice is the staple food crop and has got a tremendous influence on the economy of our country and is accounting ~78% of the net cropped area of the country [2]. The food security of Bangladesh indicates the sufficiency of rice production and is equivalent to rice security [3]. Rice is extensively grown in all

seasons of the year in Bangladesh. The climate and soil of Bangladesh are favorable for year-round rice production. There are three distinct growing seasons of rice in Bangladesh namely *Aus*, *Aman* and *Boro*. Among the seasons, transplanted aman rice covers the total area of ~5.6 million hectares with the total production of ~14.5 million metric tons of rice with an average yield of ~2.59 t ha^{-1} [4]. Rice is grown in Bangladesh over 11.7 million hectares of which transplanted aman covers 48% and contributing 38% of the total rice production [4]. National average yield is very low which is only 3.2 tons ha^{-1} [4] which is much lower compare to the yield of 6.64 tons ha^{-1} in Japan, 6.50 tons ha^{-1} in China, 6.48 tons ha^{-1} in Korea. The present yield of rice is not sufficient enough to ensure the food security for the increasing population in near future. Moreover, in our area there is no scope for horizontal expansion of areas for rice cultivation rather it is decreasing day by day (1% per year) to use of arable land for infrastructural development [5]. In our country, the cultivation area of Aus and Aman has been declined by 3.63% and 0.16%, respectively while the Boro rice cultivation area has been increased by 3.57% per year [2].

In the southwestern coastal Bangladesh T. aman is the major crop where farmers mostly cultivated long duration local aman rice varieties rather than high yielding varieties. The land category in this region is mainly low to medium highland and due to heavy rains, the high yielding dwarf varieties may not suitable as it damages due to high water level. The local varieties are taller and have the capacity to grow up with the increasing level of water. However, the yield potentiality of all the local cultivars highly varied and comparatively much lower than high yielding varieties. So, the selection of suitable variety (S) is an important decision for the low land coastal area of southwestern Bangladesh. The productivity of these cultivated local aman varieties can be increased with the use of improved agronomic practices like judicious nutrient management, timely transplanting, proper spacing, use of optimum age seedling, plant protection etc.

Age of seedling at transplanting is an important factor because it has tremendous influence on the tiller production, grain formation and other yield contributing characters [6, 7]. Generally, the farmers of Bangladesh do not give attention to the age of seedlings at transplanting and use aged seedlings. The use of over aged seedlings retards the general performance of crop and the yield of the crop reduces drastically [6, 8] as the farmers are not aware of this factor for rice production. For optimum yield, age of seedlings at

transplanting of a particular variety at a particular season is very essential consideration. Therefore, the present study was intended to evaluate the effect of optimum seedling age and suitable rice variety for the low land area of southwestern Bangladesh.

Materials and Methods

Experimental site

The experiment was conducted at the experimental field (latitude 22°47" N and longitude 89°34") of Agrotechnology Discipline, Khulna University, Bangladesh during aman season (July-December). The experimental field was typical rice growing medium high land of loamy soil and it is situated in the agro-ecological zones of Gangetic Tidal Floodplain (AEZ-13). The study area is located in subtropical climate characterized by moderately high temperature and heavy rainfall during kharif season (Fig. 1). The highest maximum and minimum temperature were prevailed in October and July, respectively (Fig. 1). The total amount of rainfall occurred during the growing season was 1377 mm of which 614 mm occurred in the month of August (Fig. 1). The textural class of the experimental field soil was clayey type. The physical and chemical properties of the experimental field soil have been shown in Table 1.

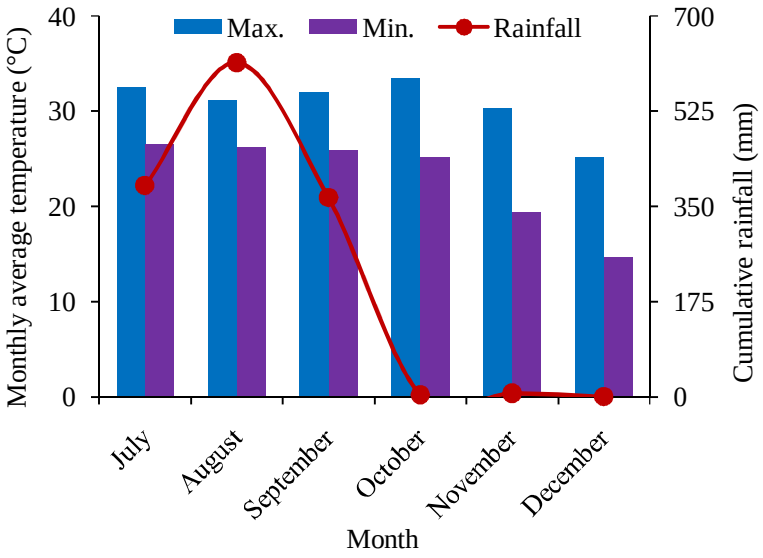

Fig. 1. Temperature and rainfall patter during the growing season in the study area.

Table 1. Physicochemical properties of the soil in the experimental site

	pH	OM	Total N	P	S	Zn	K	B
		%		µg/g soil			meq/100g soil	
Test value	7.6	2.23	0.21	4.01	458.55	1.42	0.42	0.77
Status	Neutral	Medium	Low	Very low	Very high	High	High	High

Experimental design and treatments

The experiment was arranged in a factorial randomized complete block design and replicated thrice. The individual plot size of the experiment was 10 m^2 keeping a spacing of 1.0 m and 1.5 m between plot to plot and block to block, respectively. The experimental treatments comprised of four seedlings age (15, 30, 45 and 60 days) and three local rice varieties (Ranisalute, Jatai balam and Basful balam)

Field and crop management

The field was puddled by ploughing and cross-ploughing using power tiller until a fine and soft tilth was attained. Urea, triple super phosphate (TSP), muriate of potash (MoP), gypsum and zinc sulphate were use as the source of N, P, K, S and Zn. One-third urea and total amount of other fertilizers were applied at the time of final land preparation. The rest amount of urea was topdressed in two equal splits at 30 and 60 days after transplanting (DAT). Different ages seedlings (as per the treatment) of all the rice varieties were uprooted carefully and transplanted to the field using three seedlings $hill^{-1}$ with 25 x 20 cm spacing. Intercultural operations such as gap filling, weeding, irrigation and plant protection were kept similar to all the experimental plots. The crops were harvest at full maturity.

Sampling and data collection

Growth parameters (plant height and tiller number $hill^{-1}$) were measure from randomly selected five hills. Just before harvesting ten hills were arbitrary selected for the measurement of yield attributes (effective tiller $hill^{-1}$, panicle length, grain $panicle^{-1}$, 1000-grain weight and harvest index). For the grain and straw yield, 2 m^2 area were harvested separately from each plot. The grain and straw yield of the selected area were threshed, cleaned and measured the weight at 14% moisture content and finally converted to t ha^{-1}.

$$\text{Thousand grain weight at 14\% MC} = \frac{(100 - SampleMC) \times \text{Thousand grain weight at sample MC}}{(100 - 14)}$$

$$\text{Yield (at 14\% moisture content)} = \frac{10\,(100 - \text{FMC})}{(100 - 14)} \times \frac{\text{plot yield (g)}}{\text{plot area } (m^{-2})}$$

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

Statistical analysis

The collected data of different parameters were compiled and analyzed following the analysis of variance (two way-ANOVA) technique using the statistical package 'MSTAT-C'. The separation of means among the treatments were adjudged by Duncan's Multiple Range Test (DMRT) [9].

Results and Discussion

Plant height

Seedling age, variety and their interaction had significant influence on plant height at harvest. The highest plant height was attained in the 15 days seedling which was on parity with 30 and 45-days seedling (Table 2). The higher rate of photosynthesis in the younger seedlings might be due to the higher leaf chlorophyll content that influence the crop growth. Wang et al. [10] reported the similar findings that crop growth response was higher in the earlier seedlings then gradually decreased with the use of older seedling. The results of this findings also corroborated with the findings of Ali et al., [11] who noted that 30-days older seedling produced the tallest plant. Among the varieties used in this experiment the highest plant height was observed in Rasisalute variety (Table 2). The variation in plant height among the varieties may be the genetic makeup of the variety. In the interaction effect, 15-days old seedling with Ranisalute variety produced the tallest plant while the lowest was found in 60-days old seedling with Jatai balam (Table 3).

No. of tillers hill^{-1}

At harvest 15-days old seedling significantly resulted the higher tiller number hill^{-1} which was on parity with 30-days and 45-days old seedling. The results of this study are in accordance with the finding of Liu et al., [6] and Ginigaddara and Ranamukhaarachchi [12] who noted that tiller number decreased with the increase of seedling age. However, the number of tillers hill^{-1} among the varieties and the interaction of seedling age and variety was non-significant (Table 2 & 3).

No. of effective tillers hill^{-1}

Number of effective tiller hill^{-1} was varied with the seedling age but no significant response was observed among the varieties and the interaction of seedling age and variety. The

maximum effective tiller hill^{-1} was obtained from 15-days old seedling which was statistically at par with 30-days and 45-days old seedling (Table 2). Similar findings also reported by Pramanik and Bera [13] that earlier age seedling produced the maximum effective tiller hill^{-1} than older age.

Panicle length

Panicle length was significantly higher with the use of 30-days old seedling which was statistically at par with the 15 and 45-days old seedlings while the shorter panicle length was found in older seedling (60-days) (Table 2). Faruk et al. [14] who noted that the higher panicle length was observed in earlier age seedling (21-28 days). Among the varieties Ranisalute resulted the longest panicle which as on similarity with Basful balam (Table 2). This was might be the varietal characteristic and genetic makeup of the variety. Significantly, the highest panicle length was attained due to the interaction of 15-days old seedling with Ranisalute variety which was similarity with 30-days seedling with the same variety (Table 3).

Grain panicle^{-1}

Seedling age, variety and their interaction had significant effect on grain panicle^{-1}. The maximum grain panicle^{-1} produced in 30-days old seedling which was statistically at par to 15 and 45-days seedling (Table 2). The results are in accordance with the findings of Manir et al. [15] who stated that earlier age seedling (15-35 days) significantly produced the maximum grain panicle^{-1}. Among the varieties, Jatai balam produced the highest number of grain panicle^{-1}. This was may be the greater grain bearing capacity of the variety (Table 2). 15-days old seedling with Jatai balam resulted the maximum number of grain panicle^{-1} which was statistically identical to 30-days and 45-days old seedling with the similar variety (Table 3).

Thousand-grain weight

Thousand-grain weight was significantly differed with the seedling age and the highest thousand grain weight was attained in 30-days old seedling (Table 2). The results are in accordance with the findings of Karmakar and Sarkar [16] who noticed that thousand-grain weight was highest in the earlier age seedlings. Among the variety, Ranisalute significantly produced the highest thousand-grain weight which was statistically at par with Jatai balam (Table 2). The interaction effect of 30-days old seedlings with Jatai balam significantly produced the highest thousand-grain weight which was statistically similar with 15-days old seedling using similar variety and 30-days old seedling with Ranisalute (Table 3).

Harvest index

Harvest index was varied significantly with the seedling age yet variety and their interaction of seedling age and variety had no significant influence on harvest index. The highest harvest index was attained in 60-days old seedling which was statistically equal to 30-days old seedling (Table 2). The results are confirmed by Sultana et al. [17] who noted that the harvest index was higher in the older age seedlings than earlier age.

Grain yield

Grain yield was differed significantly with the seedling age and varieties individually but their interaction was not significant. The highest grain yield was achieved from 30-days old seedling which was on similarity with 15-days and 45-days old seedling (Fig. 2A). The finding of this experiments supported by Brar et al. [18] and Saha et al. [19] who reported that improved grain yield was obtained from earlier age seedling then declining with the older age seedling. The highest grain yield in the earlier age seedlings due to the longer vegetative and reproductive period over older age seedling. The higher grain yield in the earlier age seedling was attributed with higher yield attributes. Among the varieties, Ranisalute produced the highest grain yield (Fig. 2B).

Total dry matter

30-days old seedling significant resulted the highest total dry matter accumulation which was on similarity with 15 and 45-days old seedling (Fig. 3A). Khatun et al. [20] noticed that total dry matter accumulation of *T. aman* rice varied with the seedling age and 45-days seedling produced the higher dry matter compared to earlier and older seedling. The result of this study also supported by Virk et al. [21] that earlier age seedlings produced more dry matter than older age seedling. Total dry matter accumulation was influenced significantly among the varieties and the highest dry matter accumulation was attained in Ranisalute which was statistically at par with Jatai balam (Fig. 3B). The interaction effect of seedling age and variety on total dry matter was not significant.

Table 2. Effect of seedling age on growth and yield attributes of aman rice varieties.

Treatments	Plant height (cm)	No. of tiller hill^{-1}	No. of effective tiller hill^{-1}	Panicle length (cm)	No. of grains panicle	1000 grain weight (g)	Harvest index (%)
Seedling age							
15-days	155.90a	8.90a	7.62a	21.81a	82.04a	26.79ab	34.48b
30-days	155.39a	8.71a	7.56a	22.12aRa	83.42a	27.71a	34.94b
45-days	152.76a	8.40a	7.13a	21.48a	81.43a	25.78b	36.87a
60-days	130.22b	6.82b	5.87b	19.29b	58.43b	23.44c	36.90a
Significant level	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*
Variety							
Ranisalute	155.60a	8.34	7.18	21.99a	72.27b	28.11a	35.03
Jatai Balam	142.11b	8.08	7.05	20.12b	80.82a	27.55a	35.53
Basful balam	147.99b	8.20	6.90	21.41ab	75.90b	22.13b	36.83
Significant level	*<0.01*	*ns*	*ns*	*<0.05*	*<0.01*	*<0.01*	*ns*
CV (%)	3.83	6.25	6.88	3.57	2.21	2.23	4.90

CV is the co-efficient of variation; Figure in a column having similar letter(s) do not differ significantly and having dissimilar letter(s) differ significantly

Table 3. Interaction effect of seedling age and variety on growth and yield attributes of rice

Seedlings age	Variety	Plant height (cm)	No. of tiller hill^{-1}	No. of effective tiller hill^{-1}	Panicle length (cm)	No. of grains panicle	1000 grain weight (g)	Harvest index (%)
15-days	Ranisalute	166.43a	9.43	8.13	23.46a	78.96c	28.22b	33.49
	Jatai balam	155.20cd	8.53	7.53	20.33c	92.07a	28.80ab	34.98
	Basful balam	162.07ab	7.73	7.20	21.64b	75.11d	23.33de	34.96
30-days	Ranisalute	160.07bc	8.67	7.40	22.81ab	89.59ab	29.47ab	34.50
	Jatai balam	147.13ef	8.67	7.67	21.84b	90.40ab	29.93a	34.42
	Basful balam	152.64de	8.80	7.60	21.72b	80.27e	23.73d	35.89
45-days	Ranisalute	158.50b-d	8.27	7.00	22.09b	68.47e	28.40b	36.24
	Jatai balam	144.03f	8.13	6.93	20.26c	89.13ab	26.80c	36.33
	Basful balam	146.07f	8.80	7.47	22.09b	86.69b	22.13e	35.05
60-days	Ranisalute	137.40g	7.00	6.20	19.60c	62.07f	26.33c	35.89
	Jatai balam	122.07i	7.00	6.07	18.07d	51.68g	24.67d	36.41
	Basful balam	131.20h	6.47	5.33	20.19c	61.55f	19.33f	38.41
Significance level		*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*	*<0.01*
CV (%)		3.83	6.25	6.88	3.57	2.21	2.23	4.90

CV is the co-efficient of variation; Figure in a column having similar letter(s) do not differ significantly and having dissimilar letter(s) differ significantly

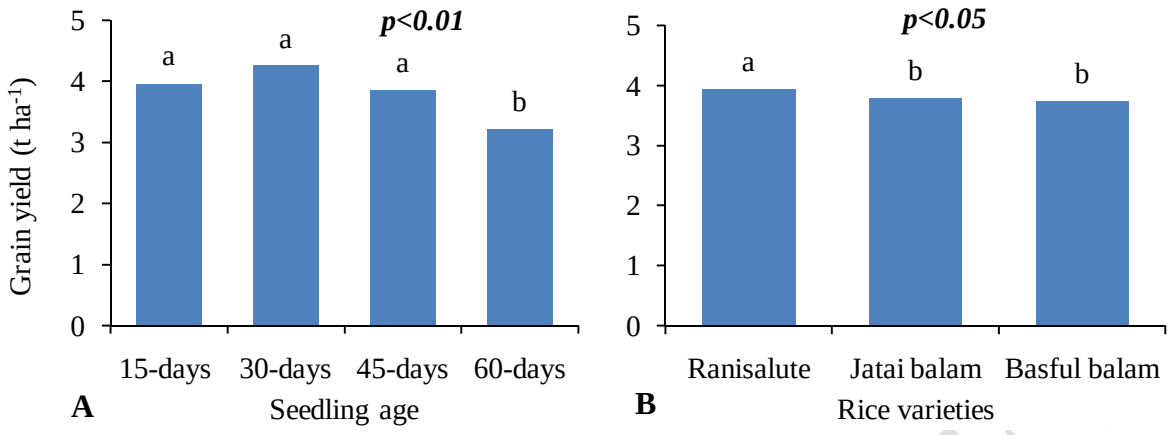

Fig. 2. Grain yield of rice due to the effect of seedling age (A) of different rice varieties (B) grown in the low land area of southwestern Bangladesh

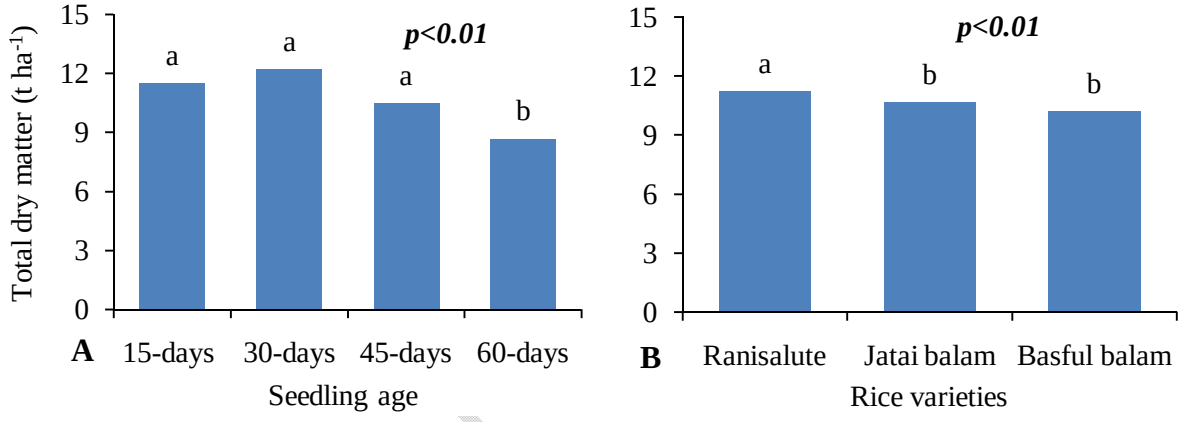

Fig. 3. Total dry matter accumulation of rice due to the effect of seedling age (A) of different rice varieties (B) grown in the low land area of southwestern Bangladesh

Relationship between grain yield and yield attributes

There was positive and significant correlation exist between the grain yield and panicle length of rice (Fig. 4A). The increased of grain yield with the increase of panicle length could be explained at 65% with the linear regression equation of y = 0.2184x - 0.8028. The correlation between the grain yield and grain panicle was positive and significant (Fig. 4B). The relationship between grain yield and grain panicle^{-1} could be clarified at 54% with the regression equation of y = 0.0233x + 2.0433. The grain yield of rice varied from 3.20 to 4.34 t ha^{-1} with the variation of grain panicle^{-1} from 52 to 92. The relationship between grain yield and 1000-grain weight of rice was positively and significantly correlated (Fig. 4C). The linear relationship between grain yield

and 1000-grain weight could be explained at 37% with the functional equation of y = 0.0758x + 1.8578.

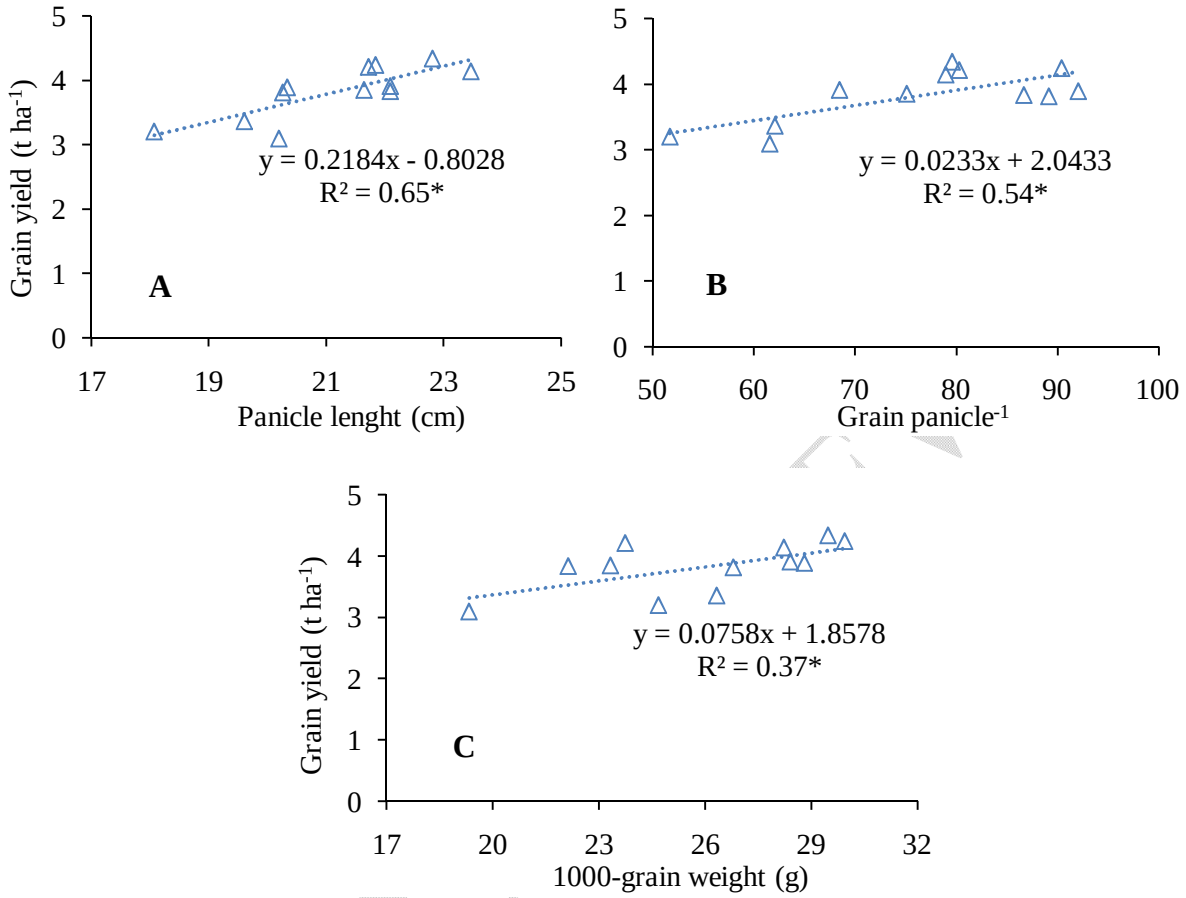

Fig. 4. Relationship of grain yield of rice with yield panicle length (A), grain panicle^{-1} (B) and 1000-grain weight (C)

Conclusion

Seedlings age substantially influence the growth, yield attributes and yield of rice varieties. Earlier age seedling (30-days) improved the grain yield of rice yet the growth and few yield attributes were higher with the use of younger seedlings (15-day). Among the varieties used Ranisalute improved the grain yield yet the yield difference was not remarkable. From the findings of this study, it could be concluded that Ranisalute variety with 30-days seedling is better in the low land area of southwestern Bangladesh.

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