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"EFFECT OF SEEDLING AGE ON GROWTH AND YIELD OF LOCAL AMAN RICE VARIETIES"

By

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ABSTRACT

A field experiment was conducted at the Dr. Purnendu Gain Field Laboratory Agrotechnology Discipline, Khulna University, Khulna from July to December 2011 to find out effect of seedling age on yield and yield attributes of different local aman rice varieties. The experiment was laid out in a double factor randomized complete block design with three replications. The experiment was consisted three local aman rice varieties such as Rani selute, Jatai balam and Basful balam and four different seedling ages *viz;* 15, 30, 45 & 60 day old seedlings. Variety and seedling age had significant impact on plant height and tiller number at different days after transplanting. Variety Rani selute produced the highest plant height, tiller number, effective tiller number hill^{-1}, panicle length, 1000 grain weight, grain yield and biological yield. While variety Jatai balam possessed the number of grains panicale^{-1}. Among the four seedling ages the performance of 15, 30, and 45 day old seedling were found better where 30 day was the best. In respect of age, the performance of 60 day old seedling was found poor. Interaction of variety and seedling age had significant effect on plant height, panicle length, number of grains panicale^{-1}, number of filled grains panicale^{-1}and 1000 grain weight. The highest number of grains panicale^{-1}(110.33) and the filled grains panicale^{-1}(92.07) were observed in Jatai balam in response to 15 day old seedling as well as the highest 1000 grain weight(29.93g) was also found in the same variety due to 30 day old seedling. Grain yield, biological yield and harvest index did not vary significantly due to the interaction of variety and seedling age. However numerically the highest grain yield (4.34 tha^{-1}) and biological yield (12.57 tha^{-1}) was recorded from Rani selute with 30 day old seedling.

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CHAPTER I

INTRODUCTION

Rice (*Oryza sativa* L.) belongs to cereal crops under Gramineae family. It is one of the major and most extensively cultivated cereals of the world including Bangladesh that feeds half of the total population. It is the most important cereal crop in Asia about 92% of the world rice (IRRI, 1995) is produced in this Continent. 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. It is the only source of cash income for many farmers (BARC, 1993). About 80 % of the total cultivated lands are used for rice production (AIS, 1992). It is grown over 10.6 million hectares under diverse irrigated and rain fed conditions (BRRI, 1991). Bangladesh is devoted to rice production (AIS, 2001). As a global food it has also a large influence on human nutrition and food security all over the world. In Asia, where people obtains 60 to 70 percent of their caloric intake from rice and its derived products (FAO, 2003). In our country rice ranks the first position among the cereal crops grown and the main source of carbohydrate. It plays an absolutely dominant role in country's agriculture as it covers 77 % of the total cropped area and 94 % of the total food grain production (BBS, 2004).

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 namely *aus, aman and boro* in Bangladesh. Among the seasons, transplanted *aman* rice covers the largest area of about 5.19 million hectares and the highest production of about 11.64 million metric tons (BBS, 2011). Rice is grown in Bangladesh over 10.2 million hectares of which transplanted *aman* contributing to 53 % of the total rice production (BBS, 2011). National average yield of rice is very low which is only 3.77 tons ha^{-1}(BBS, 2011) compare to the yield of 6.3 tons ha^{-1} in Japan, 6.5 tons ha^{-1} in Korea, 6.4 tons ha^{-1} in Australia (Karim, 1992).

The present yield of rice is not sufficient enough to ensure the food security for the increasing population in near future. Moreover, there is no scope for horizontal expansion of land areas for rice cultivation rather it is decreasing day by day to use of

arable land for infrastructural development. Actually since, 1995, the area under rice cultivation in the country has been continuously declining annually at an average of 0.61% due to urbanization at industrialization (Anwar, 1999).

Among other yield determining factors age of seedling is important because it has tremendous influence on the tiller production, grain formation and other yield contributing characters (Islam and Ahmad, 1981; BRRI, 1981). 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 retard the general performance of crop and the yield of the crop reduces drastically (Mandal and Mahapatra, 1968; BRRI, 1981) as the farmers are not aware of this factor for rice production. Age of seedlings at transplanting of a particular variety at a particular season may not be suitable for other varieties at other season. So, it is very important to find out the optimum age of seedling of a particular variety for a particular season. In Bangladesh, little research work has so for been done to identify the optimum seedlings age of local *aman* rice. It is therefore, high time to find out the optimum seedling age of local *aman* rice varieties for proper growth and higher yield.

In view of the above discussions, the present study was undertaken with the following objectives:

i) to observe the effect of seedling age on the growth and yield of local *aman* rice varieties

ii) to find out the optimum seedling age for optimum growth and higher yield of local transplanted *aman* rice.

iii) to observe the interactions between variety and seedling age on the yield performance of local transplanted *aman* rice.

CHAPTER II

REVIEW OF LITERATURE

A number of scientists worked on rice under different aspects. Yield of local *aman* rice may be influenced by several factors. Variety and seedling age have considerable effect on the growth and yield of rice. A number of experiments have been conducted in Bangladesh and elsewhere in the world to study the effect of variety and seedling age on the performance of local *aman* rice. In this chapter, an attempt has been made to review some of the available information related to the effect of variety and age of seedlings on the performance of rice.

2.1 Effect of variety on growth and yield contributing characters of rice

Babikar (1986) carried out an experiment with rice cv. Giza171 and Giza180 and also observed that number of total tillers hill^{-1} was significantly affected by the varieties.

Kamal *et al.* (1988) pointed out that among four rice varieties, BR40 produced the highest grain yield and Pajam yielded the lowest.

Rafey *et al.* (1989) reported that weight of 1000-grain differed among the cultivars studied.

The superiority of promising line over the high yielding varieties in respect of grain yield recorded by Bhuiyan and Saleque(1989).

Idris and Matin (1990) conducted an experiment with different rice varieties and reported that panicle length differed among varieties.

Motomatsu *et al.* (1990) found that the semi dwarf variety had highest yield, higher panicle hill^{-1} larger dry matter accumulation in grains after panicle formation from Japanese varieties.

Alam (1991) reported in a varietal trail in the haor area in the *boro* season that the straw yields of BR2, BR3, BR11, BR14, IR8 and Pajam were 4.8, 5.7, 6.7, 7.2, 5.6 and 5.7 t ha^{-1}, respectively

Chowdhury *et al.* (1993) stated that the variety BR23 showed superior performance to Pajam, i.e. in terms of number of productive tillers hill^{-1}, length of panicle, weight of 1000-grain. On the other hand, Pajam produced significantly taller plants, higher number of total spikelets panicle^{-1} and unfilled spikelets panicle^{-1}.

BINA (1993) reported that variety differed significantly in plant height.

Jangkaewwahara *et al.* (1993) observed that grain size and rate of filling decreased from the upper to the lower part of the panicle. The ranges among grain growth curves from the upper, middle and lower parts of the panicle of the very early and early maturing cultivars were greater than those of intermediate and late maturing varieties.

BRRI (1994) found out the performance of BR14, Pajam, BR5 and Tulsimala. Tulsimala produced the highest number of spikelets and BR14 produced the lowest. They observed that finer the grains size, the highest was the number of spikelets.

BRRI (1995a) concluded that BR41 and BR40 were found to produce better yield than Nizersail, Rajasail and Kajalsail.

BRRI (1995b) find out varietal performance of BR4, BR10, BR11 and BR25 including three local checks Rajasail, Challish and Nizersail planted at 20 cm x 20 cm spacing with 2-3 seedlings hill^{-1}. The results indicated that BR4, BR10, BR11, Challish and Nizersail produced yield of 4.38, 3.12, 3.12, 3.12 and 2.70 t ha^{-1}, respectively. Challish variety followed earlier than all other varieties.

BRRI (1995c) in an experiment with cv. BR1O, BR22, BR23 and Rajashail at three locations in *aman* season observed that BR23 yielded the highest (5.71 t ha^{-1}) and Rajashail yielded the lowest (3.63 t ha^{-1}).

BRRI (1995d) conducted an experiment including modern varieties of BR22, BR25 and Nizersail during the transplant *aman* season at three locations of Rajshahi such as

Godagari, Noahata and Puthia. In all three locations, BR25 yielded the highest and the farmer preferred it due to its fine grain yield and straw qualities.

BRRI (1995e) concluded that BR4 and BR10 were found to produce better yield than Rajasail and Kajalsail.

BRRI (1995f) conducted an experiment with rice cv. BR10, BR23 and Rajasail (ck) at three locations in *aman* season. It was found that BR23 yielded the highest (5.71 t ha^{-1}), BR22 (S.02 t ha^{-1}) and the check Rajasail yielded the lowest (3.63 t ha^{-1}). Growth duration of BR22, BR23 and Rajasail yielded lowest (3.63 t ha^{-1}

BRRI (1995g) stated that average plant height of BR3, BR7, BR29 and Iratom 24 were 95 cm, 125 cm,95 cm and 80 cm, respectively.

Hari *et al.* (1997) conducted a field experiment during wet season of 1993 and 1994 with rice cv. ORI 161 PMSZA/IR31802, 10A/PR106 and HBKR 126 and showed that hybrid OIR 161 was found significantly superior in plant height, panicle length and grain yield to hybrid PMSZA/IR31802, PMS 1 0A/PR106 and variety BKR.126. Hybrid PMSZA/IR31802, PMS1OA/PR106 and variety BKR 126, Hybrid PMSZA/IR31802 produced the highest number of effective tillers m^{-2} but was at per with OIR 161.

Roman (1997) reported that all the five cultivars studied significantly differed for the yield contributing characters and BR11 produced the highest grain yield followed by BR10, BR22, BR23 and Nizershail.

BRRI (1997) reported that three modern upland rice cultivars namely BR20, BR21, BR24 were suitable for high rainfall belts of Bangladesh. Under proper management, the grain yield were 3.5, 3.0, 3.5 t ha^{-1} for BR20, BR21 and BR24 respectively.

Dwivedi (1997) reported that fine rice cultivars Kamini, R.P. 615, Harbans, Basmati, Kasturi and Sugandha produced yield of 2.43, 1.94, 1.92, 2.01 and 2.56 tha^{-1}, respectively.

Dutta (1998) carried out an experiment with two rice varieties (BR11 and Binasail) and one mutant line (BINA163). He noticed that plant height, total tillers $hill^{-1}$, panicle length, grains $panicle^{-1}$ and 1000 grain weight differed significantly among the varieties. Variety had significant effect on plant height.

Kamal *et al.* (1998) carried out an experiment with BR3, IR20 and Pajam. They found that number of grains $panicle^{-1}$ were 107.6, 123 and 170.9 respectively for the three varieties.

Shamusuddin *et al.* (1998) conducted an experiment with 9 different rice varieties and observed that plant height differed significantly among the varieties.

Kamal *et al.* (1999) grew 17 modern rice cultivars under irrigated condition. The highest grain yield was obtained from BR18 (4.94 t ha^{-1}) followed by BR9, BR14 and BR3 respectively.

Kamal *et al.* (1999) evaluated 17 modern rice cultivars grown under irrigated condition during December 1993 to April 1994 at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. They found that straw yield was the highest in BR18 (6.25 t ha^{-1}) followed by BR3, BR14 and BR9.

Bhowmick and Nayak (2000) reported that among two hybrids ($CNHR_2$ and $CNHK_3$) and two high yielding varieties (IR23 and IR64) of rice $CNHR_2$ produced more number of panicle bearing tillers (413.4 m^{-2}) and filled grains $panicle^{-1}$ (111.0) than any other variety whereas IR36 gave the highest 1000 grain weight (21.7g),number of panicle m^{-2} and grains $panicle^{-1}$.

Naher *et al.* (2000) conducted an experiment in the net house in the Department of Agronomy, Bangladesh Agricultural University, Mymensingh during June 1994 to October 1995 to evaluate the growth duration and yield performance of BR11 and BR14 rice varieties as affected by year round transplanting. The average crop duration, anthesis and maturity durations were higher in BR11 than BR14.

Patel (2000) reported varietal performance of Kranti and IR36. He observed that Kranti produced significantly higher grain and straw yield than IR36. The mean yield increased with Kranti over IR36 was 7.1 and 10.0% for grain and straw, respectively. Kranti showed superiority, over IR36 due to production of taller plants, more number of tillers and heavier grain weight as well as stiff straw.

Sharma and Singh (2000) found that the relationship of physical characters with the grain yield of 22 rice varieties was significantly and positively correlated with net assimilation rate (0.3609), leaf area index (0.7961), photosynthetic rate (0.9555) and total dry matter (0.8829). Total dry matter and photosynthetic rate had very high positive direct and indirect effects on grain yield.

Nuruzzaman *et al.* (2000) worked with 14 varieties of rice and found that plant height and specific leaf area had a strong negative and positive correlation, respectively with the maximum tiller number.

Singh *et al.* (2000) conducted a field experiment during *rainy* season of 1996-97 with cultivars Sugandha, Basmati 370, Basmati and BR10 and showed that Pusa Basmati gave significantly higher grain yield (2930 kg ha^{-1}).

Balaswamy *et al.* (2001) worked out a field experiment during the *rainy* season of 1995 and 1996 in Andra Pradesh, India. Thirty day old seedling of rice cultivars Pakistan Basmati, Taraori Basmati, Pusa Basmati and RNR 16511 were planted and showed that RNR 16511 gave significantly higher grain yields of 2.95 and 3.50 t ha^{-1} in 1995 and 1996 respectively.

Ghosh (2001) studied the performance of four rice hybrids and four high yielding rice cultivars. Hybrids in general gave higher values for panicle length compared to other cultivars. Diaz *et al.* (2001) noted wide variation in panicle length, panicle type, grain per panicle, panicle weight and secondary branches panicle^{-1} among the varieties.

Pruneddu and Spanu (2001) conducted an experiment on varietal comparison of rice in Sardinia. They used 18 varieties that classified into different groups (round, medium, long A, long B and aromatic) according to grain properties. Highest yields were obtained from the long grained varieties.

Ghosh (2001) worked with four rice hybrids ($CNHR_3$, Pro Agro 6201, PDSH3S and GKS006) and four high yielding rice cultivars (MW10, IET4786, IRSO and Parijat) and concluded that hybrids had higher plant height as compared to HYV.

Hossain and Sarker (2002) conducted a field trial during *aman* season with cv. BRRI dhan32 and results revealed that the highest harvest index (48-62%) was obtained from SRI planting method, which used 15 day old seedling with the spacing of 25 cm 15 cm. The lowest harvest index (45-94%) obtained from the conventional method, which used 25 day old seedling with the spacing of 25 cm x 15 cm

Siddique *et al.* (2002) found that there were significant differences for all the parameters studied except number of tillers hill^{-1} and panicle^{-1} plant. Yang *et al.* (2001) studied the grain yield and yield components of two rice cultivars (JND_3 and JND_{13}) and found that JND_3 exhibited a higher tillering capacity than JND.

Mia (2003) reported that plant height differed significantly among BR3, BR11, BR22, Nizersail, Pajam and Badshabhog varieties in *aman* season.

Soriname and Muley (2003) studied the heritability and correlation studies of different biotic and morphological plant characters with grain yield in rice hybrids $TNRH_{10}$, $T'NRH_{13}$ and $TNRH_{18}$ and cultivar Jaya and observed that grain yield exhibited a strong positive correlation with harvest index.

Castanon (2004) conducted a study on the stability of rice varieties in four localities in Campeche, Mexico, during the spring-summer seasons of 1982 and 1983 which was compared to determine the most effective in detecting the stability of different varieties. The results showed that Pajam, Nizersail, Binasial were differed and environmentally affected at each locality.

Kumar *et al.* (2005) observed the effect of varietal differences and polishing of modern transplant aman rice. Different varieties were Jaya, Rasi, IR20 and Margala. Among them IR20 gave the yield (7.9 t ha^{-1}) and Rasi yielded (6.2 t ha^{-1}). The highest yield was in Jaya (8.4 t ha^{-1}).

Lamberts *et al.* (2007) observed that transplant aman rice varieties Pajam, Nizersail, Binasail and Puntal showed variability at different growth stages. The non-linear relationship between these varieties indicated variability in hardiness within the different rice fractions. The hardiness of the different varieties was not similar and growth yield were also different.

Yan *et al.* (2007) observed that the property of rice for grain development is a very important role increasing rice quality, and it is essential to understand the genetic effect of the genes related in high-yielding rice varieties for quality improvement which was assessed on 53 rice varieties, including certain typical indica japonica landraces.

2.2 Effect of seedling age on different crop characters and yield of rice

Panikar *et al.* (1981) observed that the straw yield was significantly higher with 21-day old seedlings than that of 28 or 35 day old seedlings.

Datt and Gautam (1988) conducted an experiment using rice cv, BRRI dhan40, BRRI dhan41, Pajam and Nizersail with 5 seedling age of 14, 21. 28, 35 and 42 day old were transplanted and observed that grain yield decreased with increasing seedling age.

Das and Mukherjee (1989) reported that seedling age had no effect on straw yield. Hariom *et al.* (1989) showed that increase in the age of seedlings from 35 to 42 day increased the grain yield significantly.

Das and Mukherjee (1989) reported that age of seedling had no significant effect on grain or straw yields of differrent rice cultivars, BRRI dhan40, BRRI dhan41, Pajam and Nizersail.

Mejos and Para (1990) showed statistically identical grain yields when seedling age varied from 10 to 40 days. Das and Mukherjee (1989) reported that 21, 28 and 35 day old seedlings of different cultivar e.g. BRRI dhan40, BRRI dhan41, Pajam and Nizersail did not affect the grain and straw yield significantly.

Rashid *et al.* (1990) observed that the 40 day old seedlings gave higher grain and straw yields than that of 20 or 60 day old seedlings.

Kamdi *et al.* (1991) reported that 1000-grain weight decreased with aged seedling used at transplanting. He reported that grain yield of Kalenga-3, SKI-6 and Sye-75 was reduced by 76.3, 53.3 and 49.3%, respectively when transplanted with 42 day old seedlings compared with 21 day.

Mannan and Siddique (1991) observed that there was no significant difference in yield obtained from transplanting 30 to 60 days old seedlings of BR11, BR22 and Nizersail rice

BRRI (1992a) conducted an experiment in the *aus* season. Twenty to 50 day old seedlings were planted at two levels of nitrogen and found that seedling age had no effect on grain yield.

BRRI (1992b) recorded from an experiment to find out the optimum seedling age for long and short duration varieties of rice during transplant *aman* season. Seedlings of BR11 and BR3 varieties were planted 3, 4, 5 and 6 weeks after sowing. The results indicated that seedling age had no significant effect on the yield of rice.

Panikar (1992) observed that the straw yield was significantly increased with 21 day old seedling than those with *28* or 35 day old seedlings. He found that 3 weeks old seedlings gave the maximum straw yield.

Roy *et al.* (1992) reported that grain weight of both the varieties (BR14 and IR50) decreased with increase of seedling ages. The grain yield from 20 to 60 and 20 to 80 days old seedling were significantly identical for BR14 and IR50, respectively.

Roy and Sattar (1992) observed that the tillering rate was influenced by seedling age. The absolute tillering rate was more in youngest seedling and as the seedling age increased, the tillering rate decreased. They also stated that within different variety the number of total tillers decreased with seedling age.

Seerai (1992) reported that 25, 30 or 35 day old seedling at IR8 and Kao Dogmalle 105 gave higher yields than 21 or 42 day old seedlings of the same varieties.

Hossain *et al.* (1993) observed that the field duration of rice decreased with increasing seedling age.

Roy *et al.* (1992) reported that grain weight of both the varieties (BR14 and IR50) decreased with increased of seedling ages. The grain yield from 20 to 60 and 25 to 80 day a old seedlings were significantly identical for BR14 and IR50, respectively.

Roy and Sattar (1992) observed that the tillering rate was more in younger seedling and the seedling age increased with the decrease of tillering rate. They also stated that within a variety the number of total tillers decreased with seedling age.

Patel *et al.* (1993) reported that higher paddy yields were obtained by transplanting 21 day old seedlings to a depth of 3-4 cm in puddle land than by transplanting 35 or 42 day old seedlings to a depth of 3-4 or 5-7 cm. They found that planting at random or at a spacing of 25 cm x 15 cm gave similar yields.

Bali (1995) conducted a field experiment in 1988-89 in Jammu and Kashmir with five to seven weeks old rice seedlings. Grain yield was higher with five week-old

seedlings in 1998 only (5.56 vs. 5.23 t ha^{-1}). Delayed in transplanting decreased grain yield.

Gaffer and Siddique (1995) observed that the seedling transplanted at the age of 28 day produced significantly the highest grain yield. But it was statistically identical with seedling of 21 and 35 day age. In *Kharif* (Monsoon) and *Rabi* (Winter) season in Tamil Nadu, eight early maturing mid season rice cultivars were planted with 20, 30, 40 and 50 day old seedling. The results showed a progressive decrease in paddy yield with the increase in seedling age (Rangasamy and Narayanasamy, 1997).

Khatun (1995) conducted an experiment with rice cv. BR3. Seedling of 30, 45, 60 and 75 day old were transplanted and it was observed that the tiller production was higher with 30 day old seedlings in transplant *aman* season than others. No significant difference in grain yield was observed from seedling age 30, 45, 60 and 75 day in transplant *aman* season.

Ali *et al.* (1995) stated that grain yields decreased with delay planting date and was higher in 40 or 50 day old seedling than 21 or 28 day old seedlings.

Islam (1996) revealed that in late transplanted crop, the yield reduction was higher with younger seedlings than older.

Sumali (1996) revealed that in late transplanted crop the yield reduction was higher with younger seedling than older. The superiority of promising lines over high yielding varieties in respect of grain yield was recorded by Bhuiyan and Saleque (1989).

Thiaphithak and Sawit-Michui (1996) observed that the 30 day old seedling gave higher yield compare to older seedling and late planting with older seedling gave higher yield than that of younger ones.

Channabasappa *et al.* (1997) reported that among the 21, 28, 35 and 42 day old seedling gave significantly highest grain yield. The seedling age of 14 and 35 day produced significant effect on the effective tillers hill^{-1} weight of 1000 grain and grain performance over 14 day old seedling.

Mozumder (1997) reported that seedling age of 15 and 30 day produced significant effect on the effective tillers hill$^{-1,}$ weight of 1000-grain and grain yield. In all the characters the 30 day old seedlings produced better performance over the 15 days old seedlings. Ali *et al.* (1995) stated that grain yields decreased with delay planting date and was higher in 60 or 70 day old seedling than 30 or 45 day old seedlings.

Rao and Raju (1997) found that the grain and straw yields were higher with younger seedlings of 25 day old than older seedlings of 35 and 45 day. Similar results were also reported by Kamdi *et al.* (1991).

Ro *et al.* (1997) reported that age of seedling at transplanting did not exert any effect on grain yield. He conducted an experiment using rice cv. Reimei, Tacback, Hanganchal and Keumgang. Seedlings of 21 or 35 day old were transplanted under tropical conditions.

Anita and Dasgupta (1998) used four different ages of seedlings (40, 50, 60 and 70 days after sowing) for transplanting and observed that early transplanting was highly productive (2.61-2.99 t ha^{-1}), delayed transplanting was only possible up to 60 day of age (2.28-2.52 t ha^{-1}).

Singh and Singh (1998) found that yield and yield attributes were affected significantly by the age of seedlings. Transplanting of 25 day old seedlings recorded significantly highest grain and straw yields. The yields were reduced by 14.16% due to planting of 35 day old and 45 day old seedlings, respectively. The higher yield with 25 day old seedlings could be attributed to significant improvement in various yield attributes like panicle m^{-2} panicle length, grains panicle^{-1} and 1000 grain weight.

Hundal *et al.* (1999) assessed the effects of various dates of transplanting and age of seedlings on rice yield. They reported that earlier transplanted (1June) rice performed better when the seedlings age was reduced from 40 to 30 days. Younger seedlings (20 days old) irrespective of date of transplanting proved better than older (40 days old) seedlings when other variables were kept constant.

A field experiment was conducted by Singh *et al.* (1999) to study the effect of three seedlings ages (30, 45 and 60 day old) on the growth and grain yield of rice. The maximum grain yield (4.10 t ha^{-1}) was recorded by 45 day old seedlings, followed by 30 day old seedlings (4.03 t ha^{-1}).

Kim *et al.* (1999a) reported that three rice varieties Namweonbyeo (early maturing), Hawasecongbyeo (medium maturing) and Dongjinbyeo (medium late maturing) were transplanted at 3 different seedling ages to investigate their growth habits in the southern plain area of Honam region in 1993. The 10-day-old seedlings had more vigorous elongation in plant height and higher tillering ability but lower effective tiller rate, when compared with 35 or 40-day-old seedlings.

Kim *et al.* (1999b) found that 10 day old seedlings had more vigorous elongation of plant height and higher tillering ability but lower effective tiller rate, when compared with 35 or 40 day old seedlings. Panicle number m^{-2} was the highest with, 10 day old seedlings, spikelets number $panicle^{-1}$ was the highest with 40 day old seedlings.

Lu *et al.* (1999) using 20, 25, 35, 40, 45, 50 or 55 day old seedlings found that yield decreased with delayed transplanting whereas Singh and Singh (1999) observed that grain yield was 4.92, 4.64 and 4.22 t ha^{-1} from transplanting 25, 35 and 45 day old seedlings, respectively.

Shi *et al.* (1999) tested 25, 30, 35, 40 or 45 day old seedlings in terms of grain yield in rice and found that yield was negatively correlated with seedlings age at transplanting. Mean yields were 6.7, 6.5, 5.9, 4.7 and 4.5 t ha^{-1} with transplanting 25,

30, 35, 40 and 45 day old seedlings, respectively. Yield with 25 or 36 day old seedlings was significantly higher than that of 40 or 45 day old seedlings.

Singh *et al.* (1999) studied the effect of three seedling ages (30, 45 and 60 day old) on the growth and grain yield of rice. The mean maximum panicle length, number of panicle m^{-2} and panicle weight of 30 day and 45 day old seedlings were significantly higher than the 60 day old seedlings. Yoshii *et al.* (1998) reported that transplanting of 20, 15 and 10 day old rice plants showed significant variation in respect of yield components and 20 day old seedlings had highest number of grains $unit^{-1}$ area and showed higher grain maturity percentage than other treatments.

Sanbagavalli *et al.* (1999) observed that 30 day old seedlings of rice cv. ADT38 gave higher yield than 20 or 40 day old seedlings of the same varieties.

Sangsu *et al.* (1999) observed that 10 day old seedlings gave more vigorous elongation of plant and higher tillering but lower effective tillers $hill^{-1}$ when compared with 25 or 40 day old seedlings.

Shi *et al.* (1999) in a field trail with 25, 30, 35 and 45 day old seedling of rice cv. II cultivar BR92 showed that grain yield were significantly higher.

Hundal *et al.* (1999) conducted a research work to see the effect of various dates of transplanting and age of seedlings at transplanting. They reported that earlier transplanted (1 June) rice performed better when the seedling age was reduced from 40 to 30 day young seedlings (20 and 30 day old), irrespective of data of transplanting proved better than older (40 day) seedlings, when other variables were kept constant.

Sangsu *et al.* (1999) recorded from aman experiment during 1995 with 14, 21, 28, 35 and 42 day old seedlings. They observed that 14 or 21 day old seedlings gave more vigorous elongation of plant and highest number of tillers but lower effective tillers $hill^{-1}$, when compared with 35 or 42 day old seedlings.

Singh *et al.* (1999) conducted an experiment during 1995 with 10, 35 and 40 day old seedlings. They observed that 10 day old seedlings gave more vigorous elongation of plant and higher tillering but lower effective tillers $hill^{-1}$. When compared with 35 or 40 day old seedlings, it was observed that number of panicles m^{-2}, number of spikelets $panicle^{-1}$ was the highest when transplanted 40 day old seedlings.

Singh *et al.* (1999) observed that age of seedling influenced significantly growth, yield attributes and grain yield of rice. The mean maximum plant height and yield attributes such as panicle length, panicle number m^{-2} and panicle weight of 42 and 28 day old seedlings were significantly higher than that of 60 day old seedlings.

Razzaque *et al.* (2000) reported that seedlings age had significant effect on plant height. 30-day-old seedlings produced the tallest plants followed by seedlings of 45-day and 60-day-old seedlings produced the shortest plants.

BRRI (2001) studied the yield potentiality of SRI method for yield maximization of *boro* and transplant *aman* rice. According to their report, in *boro* season, the highest panicle number m^{-2} (478) was produced by 10 day old seedlings followed by 15 day old seedlings (380). Higher number of filled grains $panicle^{-1}$ was obtained from 10 day old seedlings and 15 day old seedlings.

BRRI (2001) conducted two experiments at the BRRI farm, Gazipur to study the yield potentiality of SRI method for yield maximization of *boro* and transplant *aman* rice. According to their report the highest 1000-grain weight (21.5 g) was obtained from 10 day old seedlings.

Hossain (2001) reported that tall and old seedlings in seedbed caused earlier growth in plant height in the main field. But young seedlings grew faster than older ones.

Molla (2001) conducted an experiment during the 1998 and 1999 wet season in west Bengal, India to examine the performance of rice hybrids and high yielding cultivars (HYV) with different ages and seedling number of hill^{-1} and observed that 28 day old seedlings produced more grain yield than 21 days old seedlings.

Hossain and Haque (2001) reported that younger seedlings produced more number of tillers hill^{-1} than older ones. The number of basal tillers hill^{-1} increased with 30 day old seedling than 60 day old seedlings.

Padalia (2001) observed that panicle weight at flowering and at harvest decreased with increasing seedling age beyond 30 days in photosensitive variety but not in photoinsensitive varieties. Reddy and Narayana (1991) observed that number of panicles unit^{-1} area, grain panicle^{-1}, panicle length and weight of thousand grains decreased significantly with each 10 day increase in seedling age.

Molla (2001) observed the performance of rice hybrids and high yielding cultivars (HYV) with different seedlings ages. The treatments consisted of two hybrid rice (Pro-agro 6201 and CNRH3). Twenty eight day old seedlings produced more panicle number m^{-2}, and grain yield than 21 day old seedlings.

Reddy (2001) reported that younger seedlings produced more number of tillers hill^{-1} than older ones.

Uphoff (2001) stated that in SRI practice where age of seedlings was 8 day and 16 day. It produced 2.4 times more rice compared to conventional methods. Amin et al. (2001) conducted an experiment to study the effect of seedlings age on yield and spikelet sterility of two rice varieties BRRI dhan29 and Sonarbangla-1. The result showed that 40-day-old seedling for Sonarbangla1 and 50-day-old seedling for BRRI dhan29 performed the best in terms of yield.

Haque (2002) stated that plant height was significantly affected by seedlings age. He reported that 15-day-old seedlings produced tallest plant compared to 25, 35 and 45-day-old seedlings. He further noticed that the plant height decreased with the increase of seedling age.

Abu (2002) reported that with the SRI technique yield and yield components of rice showed significant difference due to seedlings age. He noticed that the average number of tillers was higher in case of 10 day old seedlings. The average grain yield (t ha^{-1}) was 6.72 and 4.42 in case of 10 and 21 day old seedlings, respectively.

Chris (2002) in a study with rice var. Taichung-176 found that among three seedling ages (10, 20 and 30-day-old), 30-day-old seedling had very high tillering (250 tillers m^{-2}) rate.

Haque (2002) conducted an experiment with 15, 25, 35 and 45 day old seedlings and found that younger seedlings produced more tiller than older ones.

Hossain (2002) found the highest number of effective tillers $hill^{-1}$ (11.31) out of 12.29 total tillers $hill^{-1}$ and the number of non-bearing tillers $hill^{-1}$ was lowest (0.98 out of 12.29 total tillers $hill^{-1}$) from 15-day old seedlings.

Uphoff (2002) reported that in SRI, transplanting of one young seedling (8-10 day old), when the plant has just developed two small leaves and the root, was still very simple, with the seed still attached, the transplanting was done carefully, this preserved the plant's potential for much greater tillering (30 to 80 tillers $plant^{-1}$) and possibly 100 or more

Khisha (2002) observed that the highest number of effective, tillers $hill^{-1}$ (27.83) out of 34.05 total tillers $hill^{-1}$ in System of Rice Intensification (SRI) practice, which was obtained from 8 day old and single seedling

Wang *et al.* (2002) conducted an experiment with SRI technique using 12 to 13 day old and 28 to 30 day old seedling. The results showed that percentage of effective tillers was higher in case of the younger seedlings.

Chris (2002) in a study with rice var. Taichung- 176 found that among three seedling ages (10, 20 and 30 day old), 30 day old seedling had very high tillering (250 tillers m^{-2}) rate.

Chopra *et al.* (2002) conducted a field experiment in Haryana, India, during the *Kharif* season of 1997 to evaluate the yield quality rice (cv. Pusa 44) transplanted at 25, 35, 45, 55 and 65 days after sowing. 35 day old seedlings had greater number of panicle $hill^{-1}$, panicle length, 1000grain weight, test weight, and seed yield than 55 day old seedlings. Seedling age did not significantly affect seed germination. Seed weight was positively correlated with seedling length, dry weight and vigor.

Yan (2002) reported that in SRI technique 8 to 12 day old seedlings of rice var. Yazal gave maximum yield of 12.79 t ha^{-1}, had 240 bearing tillers m^{-2} and 198 grains $panicle^{-1}$ with a 1000 grain weight of 27.5 g.

Rajesh and Thanunathan (2003) conducted a field experiment in Tamil Nadu, India to determine the optimum age of seedlings, for traditional rice cv. Kambanchamaba. The treatments comprised seedlings with varying ages (30, 40 and 50 day). 45days old seedlings recorded the highest growth characters, yield attributes and yield.

Upadhyay *et al.* (2003) conducted a field experiments during the *kharif* seasons of 1999/2000 and 2000/01 in Jabalpur, Madhya Pradesh, India, to investigate the effect of number of seedlings per hill (2, 3, 4 and 5) and age of seedlings (20, 30, 40 and 50-day-old) on rice cv. Kranti, transplanted on 18 and 22 July 1999 and 2000, respectively. Yield and yield attributing characters were significantly higher due to number of seedlings per hill and age of seedlings. The two seedlings per hill treatment gave the maximum net monetary

return of Rs 6469 qha^{-1} and benefit: cost ratio of 1.76, which was closely followed by 3 seedlings per hill treatment (Rs 6195 and 1.75, respectively).

Singh *et al.* (2004) showed that the effect of seedling age (21, 31, 41 and 51 day) of rice cv. Pusa Basmati-1 was investigated during *kharif* seasons of 1998 and 1999 in New Delhi, India. The highest yield of 70 q/ha was obtained in plots with 21 day-old seedlings, followed by 31-day-old seedlings. Seed yield and quality reduction was observed in seedlings aged 31 day and higher. Seedlings aged 41 day produced poor quality seeds that showed lower yield.

Ingale *et al.* (2005) conducted an experiment from 1999 to 2000 to determine the effects of seedling ages at transplanting (25, 40 and 55 day), number of seedlings per hill (one or two) on the yields of Sahyadri rice variety. A significant reduction in yield was observed with the delay in transplanting at 40 and 55-day-old seedlings over 25-day-old seedlings in 1999 and in the pooled mean of both years.

Khakwani *et al.* (2005) studied the effect rice variety cv. IR44 at different seedling age e.g. 20, 30, 40 and 50 and were kept at 5, 10, 15 and 20 cm water depth in a water pool. Meteorological findings indicated that water temperature varied up to 10 cm but became stable below this depth are essential for the growth and development of transplant aman rice.

Singh *et al.* (2005) conducted an experiment the effects of seedling age (30 and 40 day) of rice varieties FR-13, TCA-85, BRRI dhan28 and BRRI dhan36 were determined in pot experiments conducted in Uttar Pradesh, India. 3 days old seedling had no negative effects on plant growth. The interaction effects between varieties and seedling age were significant. Nutrient content in the shoot was higher in FR-13 and TCA-85 rice varieties.

Vijayakumar *et al.* (2006) conducted a field experiment during the dry season of 2003 in Coimbatore, Tamil Nadu, India, to investigate the effects of practices on growth characters and growth analysis of transplant aman rice. The treatments comprised different seedling ages (14 and 21 day), spacing (15 X 10 and 25 X 20 cm) of different varieties. But 14 days

old seedling and spacing (15 X 10 cm) of different varieties gave higher yield than the other.

From above review of literatures it is clear that yield performance of different rice varieties are influenced by ages of seedling. The literatures reviewed above suggest that a considerable amount of work is still to be carried out in order to evaluate, the effect of variety and seedling age on the performance of *aman* rice.

CHAPTER III

MATERIALS AND METHODS

The study was conducted during *aman* season from July to December 2011 at the Dr. Purnendu Gain Field Laboratory, Agrotechnology Discipline of Khulna University, Khulna-9208. To find out the effect of seedling age on yield and yield attributes of different local *aman* rice varieties. The materials used and the methodologies followed are discussed here under the following headings.

3.1 Description of the experimental site

The experimental field was typical rice growing medium high land of loamy soil and it is situated in the Agro ecological Zone (AEZ) 13, i.e., Gangetic Tidal Floodplain. The geographical situation of the experimental field is at latitude of $22^0 47'$ N and longitude of $89^0 34'$ E having subtropical climate characterized by moderately high temperature and heavy rainfall during *kharif* season. The chemical characteristics of the soil of the experimental plot have been presented in Appendix I. The monthly total rainfall, average maximum and minimum temperature and humidity during the study period have been presented in Appendix II.

3.2 Experimental design and treatments

3.2.1Experimental design

The two factor factorial experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The total numbers of plots were 36 and each plot size was 4.0 m × 2.5 m (10sq.m). Block to block distance was maintained by 1m and plot to plot by 0.5 m.

3.2.2Experimental treatments

The following two factors were included in the experiment as treatment

(a) Factor A: Variety - 03

(i) V_1 = Rani selute

(ii) V_2 = Jatai balam

(iii) V_3 = Basful balam

(b) Factor B: Seedling age - 04

(i) T_1 = 15 day old seedling

(ii) T_2 = 30 day old seedling

(iii) T_3 = 45 day old seedling

(iv) T_4 = 60 day old seedling

3.3 Management of the crop

3.3.1 Seed sprouting

Before sowing seeds in the nursery bed, they were immersed in water in bucket for 24 hours and then taken out of water and kept in gunny bags for 48 hours for sprouting.

3.3.2 Seed bed preparation

Power tiller and ladder were used to prepare the seedbed. At first, four cross ploughing were given with power tiller. The seedbed was irrigated. To produce different ages seedling as treatment wise in this study, pre germinated seeds were sown four times in the seed bed at different dates *viz;* 1st, 16th, 31st July and 15th August. The beds were kept wet by irrigation as and when required.

3.3.3 Land preparation

A power tiller opened the land of the experimental field 10 days before transplanting. It was then ploughed sufficiently in order to make the soil ready for transplanting. Weeds and stubble were removed and the field was then levelled by laddering. The experimental area was then divided into unit plots according to the design.

3.3.4 Application of fertilizers

The experimental field was uniformly fertilized with urea, TSP, MoP, Gypsum and Zinc sulphate @ 90 $kgha^{-1}$, 50 $kgha^{-1}$, 35 $kgha^{-1}$, 30 $kgha^{-1}$ and 5 $kgha^{-1}$ respectivly. One-third urea and other fertilizers were applied during final land preparation as well as two-third doses of urea applied at 30 and 45 days after transplanting.

3.3.5 Uprooting of seedlings

The seedbed was made wet by application of water before uprooting the seedlings. Different days old seedlings as treatment wise were uprooted from the wet seedbed without

causing any mechanical injury to the roots, bundled with proper care, and distributed in the respective plots for transplanting.

3.3.6 Transplanting

15, 30, 45 and 60 day old seedlings were transplanted on 30th August, 2011. Line to line and hill to hill distances were maintained by 25cm and 20cm respectively. Three seedlings hill^{-1} were given during transplanting.

3.3.7 Gap filling

Necessary gap filling was done after 5 to 6 days of transplanting with the same aged seedling.

3.3.8 Pest management

One-hand wedding was done to check weed infestation at 30 days after transplanting. No plant protection measure was taken, as there was no notable incidence of diseases and insects.

3.3.9 Water management

Cultivation was done in *aman* season, so irrigation was not important. But due to lack of water one time irrigation was made.

3.3.10 Harvest and post harvest operations

The crops were harvested at their full maturity when more than 90% of the grains turned into golden colour. The Basful balam and Jatai balam were harvested of different aged seedlings on 10th December, 2011 and Rani selute of different aged seedlings was harvested on 20th December, 2011. The harvested crop of each plot was bundled separately, tagged properly and brought to the clean threshing floor. The bundles were dried in open sunshine. Threshing was done with the help of a paddle thresher. After threshing the seeds were cleaned. The grain and straw weight for each plot were recorded after proper drying.

3.4 Sampling and data collection

Before harvesting 5 hills were collected randomly from each plot for data collection. Data were collected on the following parameters-

3.4.1 Plant height

Plant height was measured from the base of plant up to the tip of the tallest leaf or panicle after anthesis and the means were calculated. Plant height was recorded before harvest at three times *viz.* 55, 70 and 85 days after transplanting.

3.4.2 Number of tillers

The number of tillers in 5 hills were counted and the means were recorded. The number of tillers was recorded before harvest at three times *viz.* 55, 70 and 85 days after transplanting.

3.4.3 Effective tillers per hill

The number of effective tillers in 5 hills were counted and the means were calculated.

3.4.4 Panicle length

Panicle length was measured and the means were calculated.

3.4.5 Total grains per panicle

Grains of each panicle were counted and the numbers of filled and unfilled grains were separated. The counting of grains was done manually.

3.4.6 Filled grains and unfilled grains per panicle

The number of filled grain and unfilled spikelets per panicle were counted manually.

3.4.7 Thousand grain weight

Thousand clean dried grains from the seed stock of each plot were counted separately and weighed by an electric balance and adjusted at 14 % moisture content (MC) by using following formula.

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

3.4.8 Grain yield

To determine grain yield from each plot central two square meter of crops were harvested, bundled separately and tagged properly. Threshing was done separately. After proper drying it was weighed by using a electric balance and converted the yield into 14% moisture by using below mentioned formula and express in t ha^{-1}.

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

3.4.9 Straw yield

To determine straw yield from each plot central two square meter of crops were harvested, bundled separately and tagged properly. Threshing was done separately. After proper drying it was weighed by using an electric balance and converted the yield in t ha^{-1}.

3.4.10 Biological yield

Grain yield and straw yield are altogether regarded as biological yield. The biological yield was calculated with the following formula:

Biological yield = Grain yield + Straw yield.

3.4.11 Harvest index (%)

It is the ratio of economic yield to biological yield and was calculated with the following formula:

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

3.5 Data analysis

All the collected data were analyzed following the analysis of variance (ANOVA) technique and mean differences were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984) using a computer operated program named MSTAT-C.

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Effect of varieties on growth characters of local *aman* rice

4.1.1Plant height

Plant height varied significantly among the varieties for all growth stages except at 85 days after transplanting (Appendix V). The plant height ranged between 142.11 and 155.60 cm. Plant height gradually increased up to harvest and at harvest the highest plant height (155.60 cm) was observed from Rani selute and the lowest plant height (142.11cm) was found in Jatai balam which was statistically similar to Basful balam (Appendix III and Figure 1). BRRI (1991) also reported that plant height differed among the varieties.

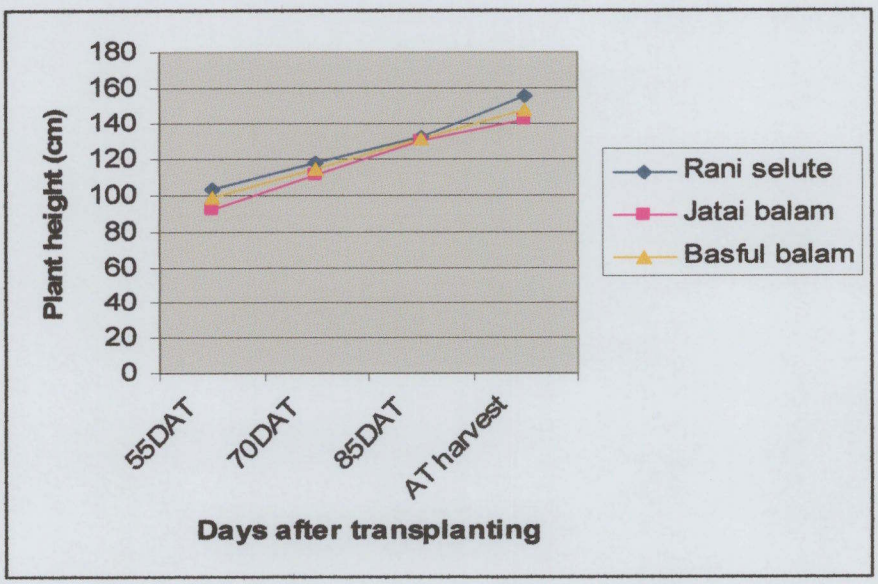

Figure1. Effect of different varieties on plant height at different days after transplanting

4.1.2 Number of tillers hill^{-1}

Variation in tiller number among the tested varieties was found significant at 55 DAT but in other stages it was statistically similar (Appendix V). The highest tiller number was observed at 55 DAT and it was decreased latter on. Variety Rani selute produced higher number of tiller followed by Basful balam. The highest tiller number (11.25) was found in Rani selute at 55 DAT and the lowest tiller number (8.08) was found in Jatai balam at harvest (Appendix III and Figure 2). Idris and Matin (1990) observed the variable effect of variety on number of tiller hill^{-1}.

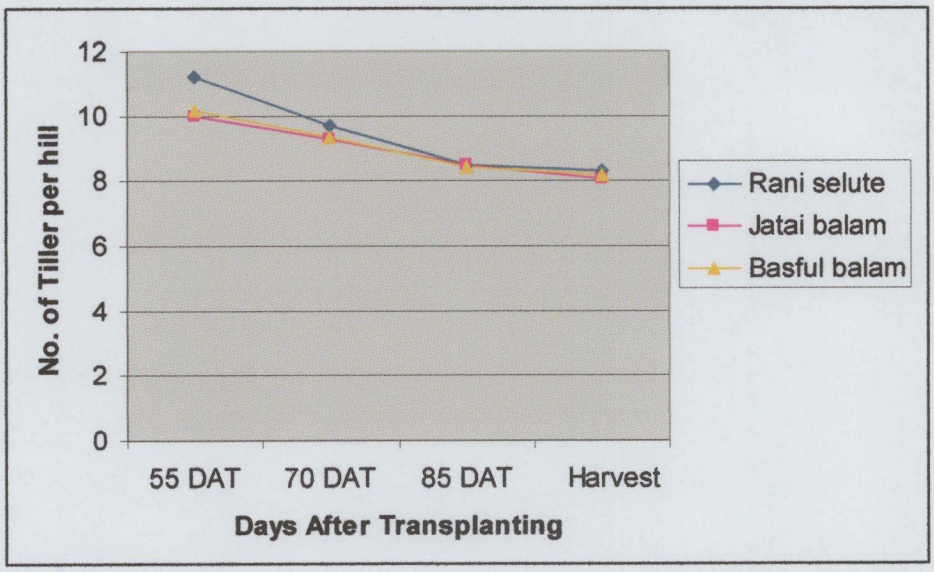

Figure2. Effect of different varieties on number of tiller hill^{-1} at different days after transplanting

4.2Effect of seedling age on growth characters of local aman rice varieties

4.2.1Plant height

Plant height was significantly influenced by seedlings age up to harvest (Appendix V). It was found that 15 day old seedlings produced the tallest plant (155.90 cm) at harvest which was statistically similar to 30 day old seedlings (155.39 cm) and 45 day old seedlings (152.76 cm). The shortest plant was produced from 60 day old seedlings (Appendix IV and Figure3). Haque (2002) stated that plant height was significantly affected by seedlings age.

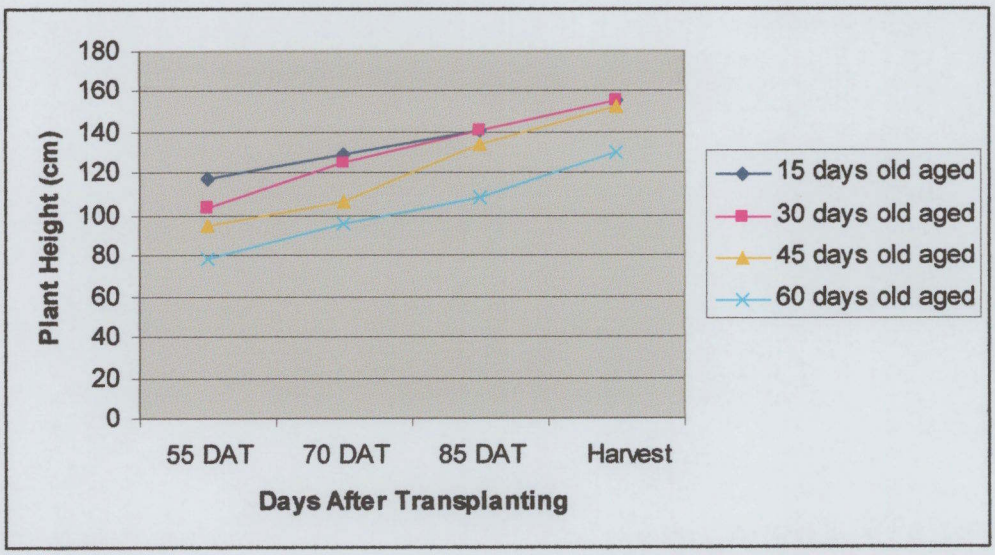

Figure3: Effect of different seedling age on plant height at different days after transplanting

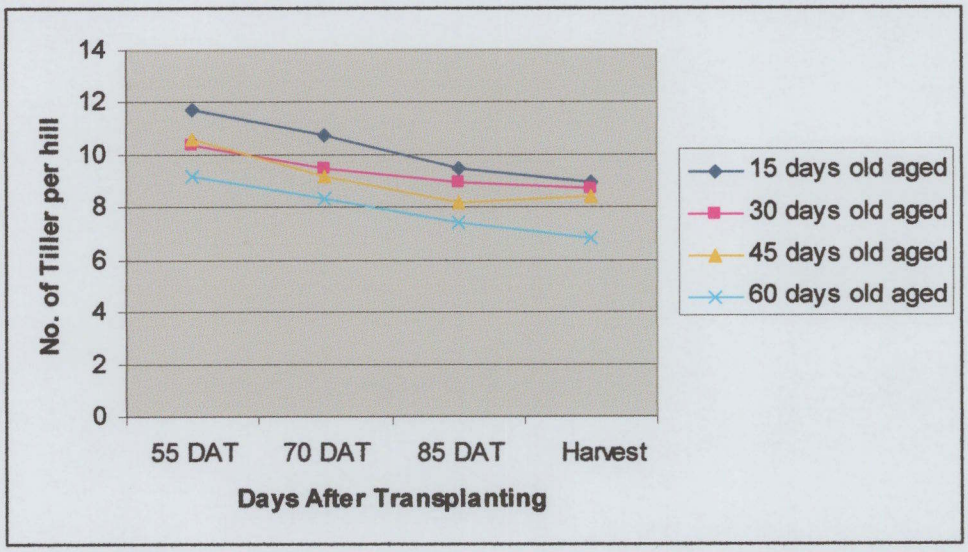

Figure4. Effect of different seedling age on number of tiller hill^{-1} at different days after transplanting

4.2.2 Number of tillers hill^{-1}

The number of tillers hill^{-1} was influenced significantly at 1% level by seedlings age at 55, 70 and 85 day after transplanting and at harvest (Appendix V). The number of tillers hill^{-1} was the highest at 55 DAT then decreased up to harvest. It ranged between 6.82 to 8.90 at harvest. The maximum number of tiller was observed from 15 day old seedlings which was statistically similar to 30 and 45 day old seedlings. 60 day old seedlings produced the lowest tiller (Appendix IV and Figure 4). This result was supported by Reddy (2002).

4.3 Interaction effect of variety and seedling age on growth characters of local *aman* rice

4.3.1Plant height

Plant height varied significantly at 1% level at 55, 70 and 85 days after transplanting and at harvest due to interaction between variety and seedling age (Appendix V). At harvest it ranges between 122.07 and 166.43cm (Table 1). The tallest plant was found in Rani selute with 15 day old seedling and the shortest plant was observed in Jatai balam in response to 60 days old seedling.

4.3.2 Number of tillers hill^{-1}

The number of tillers hill^{-1} had no marked effect at 70 days after transplanting and at harvest but it differed significantly at 55 and 85 days after transplanting (Appendix V). Results revealed that number of tillers hill^{-1} were the highest at 55 DAT and it ranged between 8.87 and 13.80 at 15 DAT and 7.00 and 10.0 at 85 DAT. At 55 DAT the maximum number of tiller hill^{-1} (13.80) was observed in Rani selute due to 15 day old seedlings and the lowest tiller was observed in Basful balam for 60 day old seedlings. Although the number of tiller hill^{-1} was not differed significantly but numerically differed from each other at harvest which ranged from 6.47 to 9.43 (Table 1). The lowest number of tiller hill^{-1} was found in Basful balam (6.47) in response to 60 day old seedlings.

4.4Effect of variety on yield and yield attributes of local *aman* rice

4.4.1Number of effective tiller hill^{-1}

There were significant differences observed among varieties for effective tiller hill^{-1} (Appendix VI). The maximum number of effective tillers hill^{-1} was produced by Rani selute (7.18) which is similar to Jatai balam (7.05) (Table 2). BRRI (1991) reported that the number of effective tillers significantly differed with variety to variety.

4.4.2Panicle length

Panicle length was greatly varied among the varieties (Appendix VI). The longest panicle was found in Rani selute (22.99 cm) which was statistically similar to Basful balam (21.41 cm) and the shortest panicle was found in Jatai balam (20.12 cm) (Table 2).

4.4.3Number of grains panicle^{-1}

Number of grains per panicle varied significantly among the varieties (Appendix VI). It ranged between 88.95and 100.67. The highest number of grains per panicle was observed in Jatai balam which was statistically similar to Basful balam (97.15). The lowest number of grains per panicle (88.95) was found in Rani selute (Table 2). The results supported by Kamal *et al.* (1998).

4.4.4 Number of filled grains panicle^{-1}

Variety possessed a significant variation in number of filled grains panicle^{-1} (Appendix VI). The maximum number of filled grains per panicle was found in Jatai balam (80.82) among the tested varieties. The minimum number of filled grains per panicle was found in Rani selute (72.27) which was statistically similar to Basful balam (75.90) (Table 2).

4.4.5 1000 grain weight

1000 grain weight differed significantly due to the effect of variety (Appendix VI). It was evident that Rani selute produced the highest 1000 grain weight (28.11g) which was statistically similar to Jatai balam (27.55g) (Table2). The lowest 1000 grain weight (22.13g) was found in Basful balam.Rafey *et al.* (1989) reported that 1000 grain weight differed among the cultivars studied.

4.4.6 Grain yield

Varieties showed significant variation on grain yield (Appendix VI). Grain yield ranged between 3.74 and 3.94 tha^{-1}. The highest grain yield was obtained from Rani selute which was statistically similar to Jatai balam (3.79 t ha^{-1}) and the lowest grain yield was found from Basful balam (3.74 t ha^{-1}) (Table 2). This result is almost similar to Patel (2000).

4.4.7 Biological yield

The biological yield varied significantly at 1% level due to the effect of variety (Appendix VI). The highest biological yield (11.24 t ha^{-1}) was produced by Rani selute which was statistically similar to Jatai balam (10.69 t ha^{-1}) (Table2). The lowest biological yield (10.21 t ha^{-1}) was produced by Basful balam.

4.4.8 Harvest Index

Varieties had significant effect on the harvest index of local aman rice (Appendix VI). However, apparently the highest harvest index (36.83 %) was produced by Basful balam

and the lowest harvest index (35.03 %) was produced by Rani selute which is similar to Jatai balam. A similar finding was also reported by Hossain and Sarker (2002).

4.5 Effect of seedling age on yield and yield attributes of local *aman* rice varieties

4.5.1Number of effective tillers hill^{-1}

Seedling age was not differed significantly on number of effective tiller hill^{-1} (Appendix VI). The number of effective tiller hill^{-1} ranged from 6.87 to 7.62 (Table3). It was observed that 15 day old seedlings produced the maximum number of effective tillers hill^{-1} (7.62) which was followed to 30 and 45 day old seedlings. These results are in agreement with the finding of Wang *et al.* (2002). It was found that the higher value (R^2 = 0.904) suggests that over 90% of the variation in yield could be defined by the variation in number of effective tiller hill^{-1} (Figure 5).

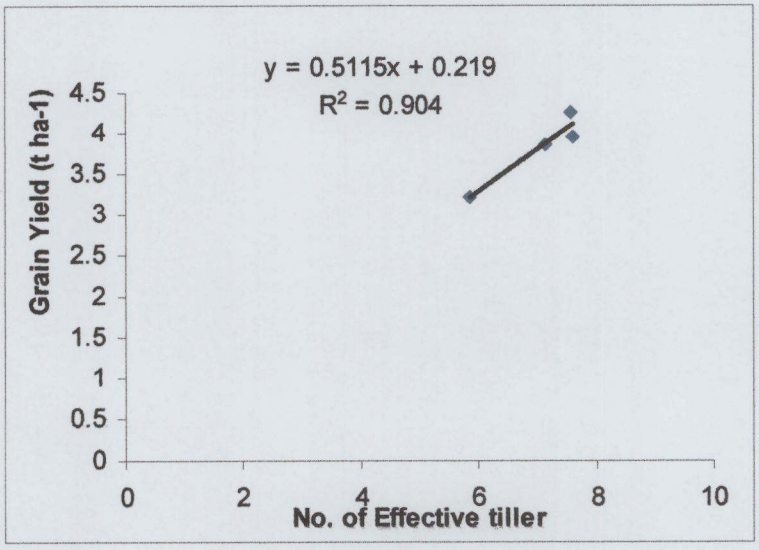

Figure5. Functional relationship between grain yield and number of effective tiller hill^{-1}

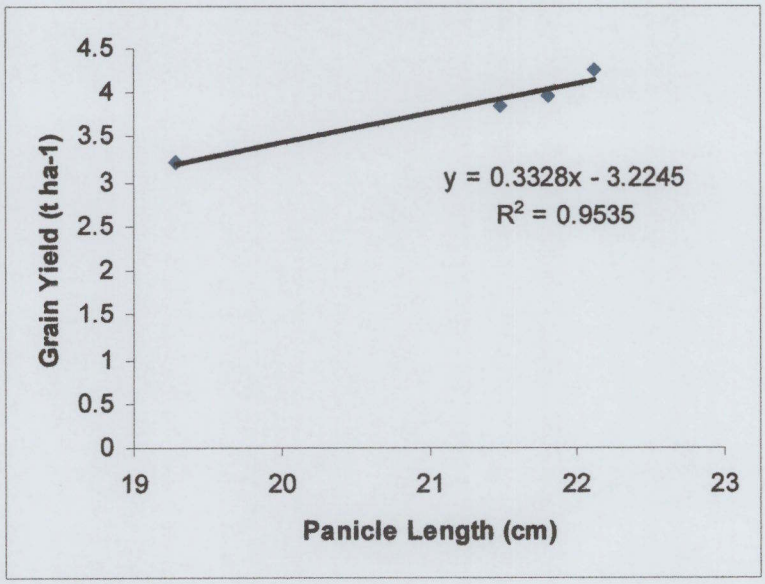

Figure6. Functional relationship between grain yield and panicle length.

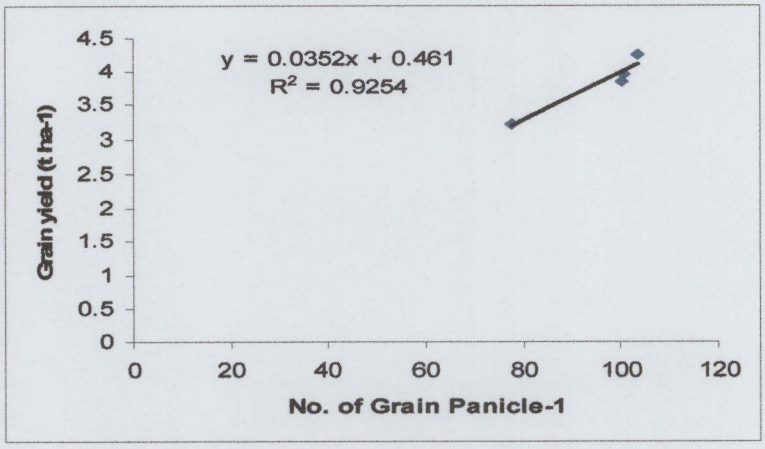

Figure7. Functional relationship between grain yield and number of grains panicle^{-1}.

Table 1. Interaction effect of different varieties and seedling age on plant height and number of tiller hill^{-1} at different days after transplanting (DAT)

Interactions	Plant height (cm)				Number of tiller hill^{-1}			
	55 DAT	70 DAT	85 DAT	At harvest	55 DAT	70 DAT	85 DAT	At harvest
$V_1 T_1$	118.27a	129.47ab	139.93a	166.43a	13.80a	11.20	9.37ab	9.43
$V_1 T_2$	108.60b	127.50abc	141.93a	160.07bc	10.47bc	9.60	9.00a-d	8.67
$V_1 T_3$	99.80cd	110.90d	133.47bc	158.50bcd	11.13b	9.33	7.93c-f	8.27
$V_1 T_4$	86.73e	102.67e	111.33d	137.40g	9.60cde	8.67	7.80def	7.00
$V_2 T_1$	112.60b	127.57abc	138.83ab	155.20cd	10.60bc	10.93	10.03a	8.53
$V_2 T_2$	101.40c	124.80bc	139.63a	147.13ef	9.87b-e	8.93	8.50b-e	8.67
$V_2 T_3$	87.60e	98.73ef	129.53c	144.03f	10.40b-d	9.00	8.03b-f	8.13
$V_2 T_4$	68.33g	94.67fg	110.47d	122.07i	9.07de	8.13	7.33ef	7.00
$V_3 T_1$	120.28a	130.93a	142.77a	162.07ab	10.87bc	10.20	8.93a-d	8.73
$V_3 T_2$	102.67c	122.67c	141.37a	152.64de	10.87bc	9.87	9.27abc	8.80
$V_3 T_3$	96.17d	111.33d	137.90ab	146.07f	10.13e b-e	9.20	8.47b-e	8.80
$V_3 T_4$	78.80f	91.13g	104.20e	131.20h	8.87e	8.07	7.00f	6.47
Level of significance	0.01	0.01	0.01	0.01	0.05	NS	0.05	NS
CV (%)	2.07	2.14	1.92	1.83	7.00	5.55	5.73	6.25

Figures in a column having similar letter(s) do not differ significantly where as figures in a column having dissimilar letter(s) differ significantly.

T_1: 15 day old seedlings; T_2: 30 day old seedlings; T_3: 45 day old seedlings; T_4: 60 day old seedlings

V_1: Rani selute ; V_2: Jatai balam; V_3: Basful balam. DAT: Days after transplanting

CV: Co-efficient of variation

NS: Non significant

Table 2. Effect of varieties on yield and yield attributes of local aman rice

Varieties	No. of effective tiller hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of filled grains panicle^{-1}	1000 grain wt. (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
Rani selute	7.18a	21.99a	88.95b	72.27b	28.11a	3.94a	11.24a	35.03b
Jatai balam	7.05a	20.12b	100.67a	80.82a	27.55a	3.79a	10.69a	35.53b
Basful balam	6.90b	21.41ab	97.15a	75.90b	22.13b	3.74b	10.21b	36.83a
CV (%)	6.88	3.57	2.22	2.21	2.23	4.26	6.20	4.90
Level of significance	0.01	0.01	0.01	0.01	0.01	0.05	0.01	0.01

Figures in a column having similar letter(s) do not differ significantly where as figures in a column having dissimilar letter(s) differ significantly.

CV: Co-efficient of variation

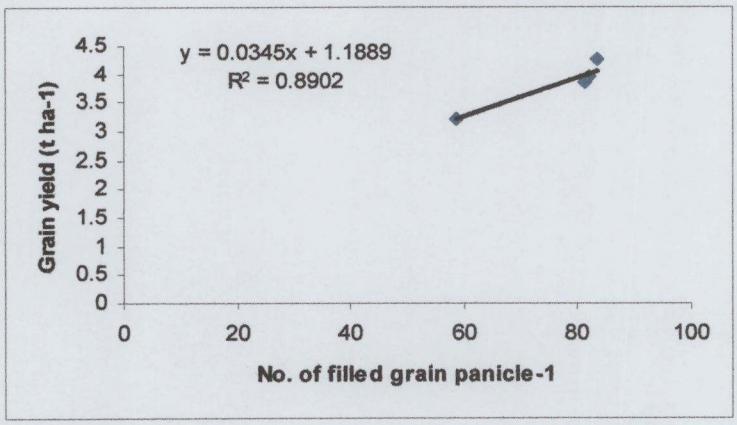

Figure8. Functional relationship between grain yield and number of filled grain panicle^{-1}

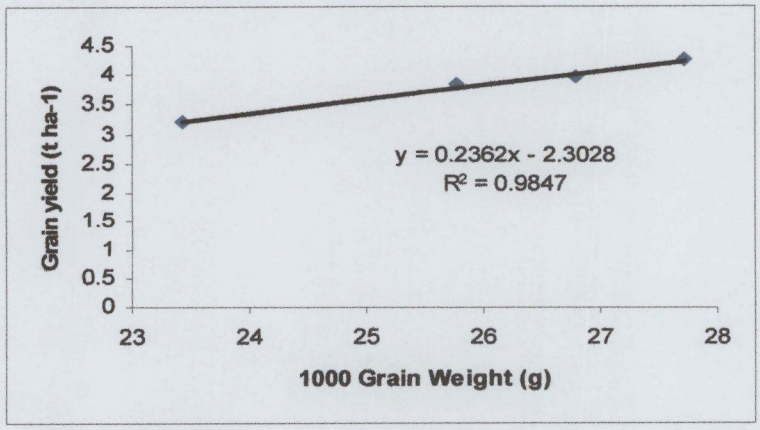

Figure9. Functional relationship between grain yield and 1000 grain weight.

Table 3. Effect of seedling age on yield and yield attributes of local *aman* rice varieties

Treatment	No. of effective tiller hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of filled grains panicle^{-1}	1000 grain wt. (g)	Grain yield (tha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_1	7.62	21.81a	100.73a	82.04a	26.79ab	3.96a	11.51a	34.48b
T_2	7.56	22.12a	103.72a	83.42a	27.71a	4.26a	12.21a	34.94a
T_3	7.13	21.48a	100.13a	81.43a	25.78b	3.85a	10.48ab	36.87a
T_4	6.87	19.29b	77.80b	58.43b	23.44c	3.22b	8.66b	36.90a
CV (%)	6.88	3.57	2.22	2.21	2.23	4.26	6.20	4.90
Level of significance	NS	0.01	0.01	0.01	0.01	0.05	0.01	0.05

Figures in a column having similar letter(s) do not differ significantly where as figures in a column having dissimilar letter(s) differ significantly.

T_1: 15 day old seedling; T_2: 30 day old seedling; T_3: 45 day old seedling; T_4: 60 day old seedling.

CV: Co-efficient of variation

NS: Non significant

4.5.2Panicle length

Seedling age had significant effect on panicle length (Appendix VI). Panicle length ranged between 19.29 and 22.12 cm (Table3). The highest value was found in 30 day old seedlings which was statistically similar to 15 and 45 day old seedlings and the lowest (19.29 cm) was observed in 60 day old seedlings. Simple linear regression showed that seed yield was dependent on panicle length in all seedling age. The higher value ($R^2 = 0.9535$) suggests that over 95% of the variation in yield could be defined by the variation in panicle length (Figure 6).

4.5.3 Number of grains panicle^{-1}

Numbers of grains panicle-1 were differed significantly at 1% level due to seedling age (Appendix VI). It was found that the highest number of grains panicle^{-1} (103.72) was produced by 30 day old seedlings which were statistically similar to 15 and 45 day old seedlings (Table 3). The lowest number of grains panicle^{-1}was found in 60 day old seedlings. The greater value ($R^2 = 0.9254$) suggests that over 92% of the variation in yield could be explained by the variation in number of grains panicle^{-1} (Figure 7).

4.5.4 Number of filled grains panicle^{-1}

Number of filled grains panicle^{-1} were influenced significantly due to seedling age (Appendix VI). The maximum number of filled grains panicle^{-1} (83.42) was produced by 30 days old seedling which was similar to 15 and 45 day old seedlings (Table 3). The lowest value was recorded from 60 day old seedling. The higher value ($R^2 = 0.8902$) suggests that over 89% of the variation in grain yield could be explained by the variation in number of filled grains panicle^{-1} (Figure 8).

4.5.5 Thousand grain weight

Seedling age had significant effect on thousand grain weight (Appendix VI). The highest thousand grain weight (27.71 g) was produced by 30 days old seedling and the lowest was found in 60 day old seedlings (Table 3). The higher value ($R^2 = 0.9847$) suggests that over

98% of the variation in grain yield could be explained by the variation in thousand grain weight (Figure 9). Almost similar results were also reported by Kamdi *et al.* (1991)

4.5.6 Grain yield

Grain yield differed significantly due to the effect of seedling age (Appendix VI). The highest (4.26 tha^{-1}) grain yield was produced by 30 day old seedling which was at par with 15 and 45 day old seedlings and the lowest grain yield (3.22 t ha^{-1}) was due to 60 day old seedlings (Table 3). The lowest grain yield by 60 day old seedlings might be due to the over age of seedling which failed to produced sufficient yield contributing characters. The result is supported by Rao and Raju (1997).

4.5.7 Biological yield:

Seedling age had significant effect on biological yield of local *aman* rice varieties (Appendix VI). The highest biological yield (8.66 t ha^{-1}) was obtained from 30 day an old seedling which was at par with 15 day and 45 day old seedlings. The lowest biological yield (8.66t ha^{-1}) was obtained from 60 day old seedlings (Table 3).

4.5.8 Harvest index

Harvest index also differed significantly at 5% level which ranged from 34.48 to 36.90% (Table3). The highest harvest index was obtained from 60 day old seedling which was statistically similar to 45 day and 30 day old seedlings. The lowest harvest index was recorded in 15 day old seedlings.

4.6 Interaction effect of variety and seedling age on yield and yield attributes of local *aman* rice

4.6.1 Number of effective tiller $hill^{-1}$

The number of effective tiller $hill^{-1}$ had no marked significant effect due to treatment combination of variety and seedling age (Appendix VI). It was varied from 5.33 to 8.13. The maximum number of effective tiller $hill^{-1}$ was observed in Rani selute for 15 day old seedlings and the least number was found in Basful balam for 60 day old seedlings (Table 4).

4.6.2 Panicle length

Panicle length was significantly influenced at 5% level by the interaction of varieties and seedling age (Appendix VI). It varied from 18.07 to 23.46 cm (Table 4). The longest panicle length (23.46 cm) was obtained from Rani selute due to 15 day old seedlings and the shortest in Jatai balam (18.07 cm) by 60 day old seedlings.

4.6.3 Number of grains panicle^{-1}

The number of grains panicle^{-1} was differed significantly due to the treatment combination of variety and seedling age which ranged between 74.44 and 110.33 (Table 4). The maximum number of grains panicle^{-1} was observed in Jatai balam (110.33) in response to 15 day old seedlings and the lowest (74.44) was found in Jatai balam by 60 day old seedlings.

4.6.4 Number of filled grains panicle^{-1}

Interaction of varieties and seedlings age had significant effect on number of filled grains panicle^{-1} which varied from 51.68 to 92.07(Table 4). The highest number of filled grains panicle^{-1} (92.07) produced in Jatai balam in response to 15 day old seedlings which was similar to that of the same variety for 30 and 45 day old sedlings and also variety Basful balam for 45 day old seedling. The lowest was found (51.68) in the same variety by 15 day old seedlings.

4.6.5 Thousand grain weight

Thousand grain weight was significantly affected by the interaction of variety and seedling age which ranged between 19.33g and 29.93g (Table 4). The highest thousand grain weight (29.93g) was produced for 30 day old seedlings in Jatai balam and lowest was obtained from Basful balam(19.33g) in response to 60 day old seedlings.

4.6.6 Grain yield

Interaction of variety and seedlings age had no significant effect on grain yield (Table 4). Numerically it differed from each other. The highest grain yield (4.34 tha^{-1}) was found in Rani selute in response to 30 day old seedlings and lowest was found in Basful balam (3.09 t ha^{-1}) in response to 60 day old seedlings.

4.6.7 Biological yield

Effect of interaction of varieties and seedlings age on biological yield was not significantly affected (Table4). It was found that the highest biological yield (12.57 t ha^{-1}) was produced in Rani selute by 30 day old seedlings. The lowest (8.03) biological yield was obtained in Basful balam by 60 day old seedlings.

4.6.8 Harvest index

Harvest index was not differed significantly due to the interaction of varieties and seedlings age (Table4). Numerically it was varied from each other which ranged between 33.49 and 38.41 %. The highest (38.41%) harvest index was found in Basful balam by 60 day old seedlings and lowest (33.49%) in Rani selute by 15 day old seedlings.

Table 4. Interaction effect of different varieties and seedling age on yield and yield attributes of local aman rice.

Interactions	No. of effective tiller hill^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	No. of filled grains panicle^{-1}	1000 grain wt. (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
V_1 T_1	8.13	23.46a	95.11e	78.96c	28.22b	4.14	12.39	33.49
V_1 T_2	7.40	22.81ab	98.07c	79.59c	29.47ab	4.34	12.57	34.50
V_1 T_3	7.00	22.09b	84.61d	68.47e	28.40b	3.91	10.86	36.24
V_1 T_4	6.20	19.60c	78.04ef	62.07f	26.33c	3.36	9.15	35.89
V_2 T_1	7.53	20.33c	110.33a	92.07a	28.80ab	3.89	11.12	34.98
V_2 T_2	7.67	21.84b	110.13a	90.40ab	29.93a	4.24	12.33	34.42
V_2 T_3	6.93	20.26c	107.80a	89.13ab	26.80c	3.81	10.50	36.33
V_2 T_4	6.07	18.07d	74.44f	51.68g	24.67d	3.20	8.80	36.41
V_3 T_1	7.20	21.64b	96.77c	75.11d	23.33de	3.85	11.02	34.96
V_3 T_2	7.60	21.72b	102.95b	80.27e	23.73d	4.21	11.74	35.89
V_3T_3	7.47	22.09b	107.97a	86.69b	22.13e	3.83	10.07	38.05
V_3 T_4	5.33	20.19c	80.91de	61.55f	19.33f	3.09	8.03	38.41
CV (%)	6.88	3.57	2.22	2.21	2.23	4.26	6.20	4.90
Level of significance	NS	0.05	0.01	0.01	0.01	NS	NS	NS

Figures having similar letter(s) differ not significantly where as figures having dissimilar letter(s) differ significantly

T_1: 15 day old seedling; T_2: 30 day old seedling; T_3: 45 day old seedling; T_4: 60 day old seedling.

V_1: Rani selute ; V_2: Jatai balam; V_3: Basful balam. DAT: Day after transplanting

CV: Co-efficient of variation

NS: Non significant

CHAPTER V

SUMMARY AND CONCLUSION

An experiment was conducted to observe the effect of seedling age on yield and yield attributes of different local *aman* rice cultivars in the Dr. Purnendu Gain Field Laboratory, Agrotechnology Discipline of Khulna University, Khulna during the period from July to December 2011. The study consisted of three local *aman* rice varieties such as Rani selute, Jatai balam and Basful balam and four different seedling ages *viz.* 15, 30, 45 & 60 day old seedling. The experiment was laid out in a double factor randomized complete block design with three replications. The unit plot size was 4m x 2.5m. Block to block and plot to plot distance was maintained by 1m and o.5m respectively. Line to line and hill to hill distance was also maintained by 25 cm and 20 cm respectively. Intercultural operations were done as and when necessary. Data recorded on plant growth characters at 55, 70 and 85 days after transplanting. Data also recorded at harvest on agronomic characters at harvest.

The highest plant height was found in Rani selute and the lowest was in Jatai balam after transplanting. Seedling age had significant effect on plant height at different days after transplanting. Out of four different seedling ages, 15 day old seedlings showed highest plant height (155.90cm) at harvest. 60 day old seedlings showed the least performance. The highest plant height (166.43cm) was observed in Rani selute with 15 days old seedlings and the lowest plant height was produced by Jatai balam with 60 day old seedlings. Results of the present study revealed that no. of tiller $hill^{-1}$ increased up to definite period after that it decreased. The maximum no. of tiller $hill^{-1}$ was found in 55 day after transplanting. Rani selute showed the best performance and Jatai balam showed the least performance for tiller production. 15 day old seedlings produced the highest tiller while 60 day old seedlings produced the lowest tiller. The maximum no. of tiller $hill^{-1}$ was found in Rani selute in response to 15 day old seedlings and the minimum no. of tiller $hill^{-1}$ was found in Basful balam in response to 60 day old seedlings.

Among the tested varieties Rani selute produced maximum no. of effective tiller $hill^{-1}$(7.18). The highest number of effective tiller $hill^{-1}$(7.62) was found by 15 day old seedlings which were statistically similar 30 and 45 day old seedlings. The maximum number of effective tiller $hill^{-1}$(8.13) was observed in Rani selute in response to 15 days old

seedlings. Cultivars and seedling age had significant effect on panicle length. Rani selute showed longest panicle length (21.99cm) and 30 day old seedlings expressed longest panicle length (22.12cm). The longest panicle length (23.46cm) was observed in Rani selute due to 15 day old seedlings. The highest no. of grains panicle^{-1} (100.67) was observed in Jatai balam. 30 day old seedlings showed maximum no. of grain panicle^{-1} (103.72). The maximum number of grains panicle^{-1} (110.33 was observed in Jatai balam due to 15 day old seedlings. Number of filled grain panicle^{-1} was differed significantly by varieties and different seedling age. Jatai balam showed the highest number (80.82) of filled grain panicle^{-1}. The highest number of filled grain panicle^{-1} (83.42) was produced by 30 day old seedlings. The maximum no. of filled grains panicle^{-1} (92.07) was found in Jatai balam due to 15 day old seedlings. Cultivars and seedling age had significant effect on 1000 grain wt. The highest 1000 grain wt. (28.11g) was found in Rani selute among the tested cultivars and it was also found (27.71g) by 30 day old seedlings. The highest 1000 grain wt. (29.93g) was observed in Jatai balam in response to 30 day old seedlings. Rani selute showed the highest (3.94 tha^{-1}) grain yield which is similar to Jatai balam. Thirty day old seedlings showed the best performance while 60 day old seedlings showed the least performance in case of grain yield. Interaction of variety and seedling age was not differed significantly for grain yield. The highest grain yield (4.34 tha^{-1}) was produced in Rani selute by 30 day old seedlings. Biological yield was differed significantly due to varieties and seedling age. The highest biological yield (11.24 tha^{-1}) was produced by Rani selute and 30 day old seedlings (12.21 tha^{-1}). Biological yield not varied significantly in case of interaction but numerically the the highest biological yield was in Rani selute (12.57 tha^{-1}) in response to 30 day old seedlings. Harvest index was not varied significantly for variety but was varied for seedling age. Sixty day old seedlings had the highest harvest index which is similar to 15 and 30 day old seedling. No significant variation was observed for harvest index due to interaction of variety and seedling age.

In conclusion it can be said that being local variety the tested three varieties are potential in respect of grain yield but Rani selute was the best. Among the four seedling ages 15, 30 and 45 day old seedling performed better while the performance of 60 day old seedling was poor.

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APPENDICES

Appendix I. Physical and chemical characteristics of soil (0-15 cm) of the experimental site.

Sl. No.	Name of the elements	Average amount of nutrients
1	pH	7.6
2	Calcium (m.e./100g. Soil)	22.75
3	Magnesium (m.e./100g. Soil)	7.00
4	Potassium (m.e./100g. Soil)	0.42
5	Total Nitrogen (%)	0.208
6	Phosphorus (µg/g Soil)	4.01
7	Sulphur (µg/g Soil)	458.55
8	Boron (µg/g Soil)	0.77
9	Copper (µg/g Soil)	10.32
10	Iron (µg/g Soil)	48.20
11	Manganese (µg/g Soil)	19.66
12	Zinc (µg/g Soil)	1.42
13	Organic matter (%)	2.23
14	Textural class	Clay

Note: Soil analysis was performed in Soil Resources Development Institute (SRDI), Daulatpur, Khulna.

Appendix II. Monthly total rainfall, temperature and relative humidity during the growing period from July to December, 2011.

Month	Monthly average temperature (^{0}C)		Rainfall	Humidity
	Maximum	Minimum	(mm)	(%)
July	32.6	26.5	388	82.1
August	31.2	26.2	614	87.6
September	32.0	25.9	366	86.4
October	33.4	25.2	003	76.7
November	30.3	19.4	006	79.5
December	25.1	14.7	Nil	87.4

Source: Weather Department, Regional Observation Centre, Gollamari, Khulna.

Appendix III: Effect of different cultivars on plant height and no. of tiller hill^{-1} at different days after transplanting

Cultivar	Plant height (cm) at				No. of tiller hill^{-1} at			
	55 DAT	70 DAT	85 DAT	Harvest	55 DAT	70 DAT	85 DAT	Harvest
Rani selute	103.33a	117.63a	131.67	155.60a	11.25a	9.70	8.52	8.34
Jatai balam	92.48b	111.44b	129.62	142.11b	9.98b	9.25	8.47	8.08
Basful balam	99.38a	114.09ab	131.56	147.99b	10.18a	9.33	8.42	8.20
Level of significance	0.01	0.01	NS	0.01	0.01	NS	NS	NS
CV (%)	2.07	2.14	1.92	1.83	7.00	5.55	5.73	6.25

Note: Figures having similar letter (s) do not differ significantly where as figures having dissimilar letter (s) differ significantly
DAT: Days after transplanting
CV: Co-efficient of variance
NS: Non significant

Appendix IV: Effect of different seedling age on plant height and number of tillers hill^{-1} at different days after transplanting

Treatment	Plant height (cm) at				No. of tiller hill^{-1} at			
	55 DAT	70 DAT	85 DAT	Harvest	55 DAT	70 DAT	85 DAT	Harvest
T_1	117.05a	129.32a	140.51a	155.90a	11.76a	10.78a	9.44a	8.90a
T_2	104.09b	125.09a	140.98a	155.39a	10.40ab	9.47b	8.92ab	8.71a
T_3	94.52c	106.99b	133.63b	152.76a	10.56ab	9.18b	8.14bc	8.40a
T_4	77.96d	96.16c	108.67c	130.22b	9.18b	8.29b	7.38c	6.82b
Level of significance	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
CV (%)	2.07	2.14	1.92	1.83	7.00	5.55	5.73	6.25

Figures having similar letter(s) do not differ significantly where as figures having dissimilar letter(s) differ significantly

T_1: 15 day olds seedling; T_2: 30 day olds seedling; T_3: 45 day olds seedling; T_4: 60 day olds seedling.

CV: Co-efficient of variation

Appendix V. Analysis of variance for vegetative growth characters of rice varieties

Source of variation	Degree of freedom (df)	Mean Sum of Square (MSS)							
		Plant height (cm)				No. of tiller hill^{-1}			
		55 DAT	70 DAT	85 DAT	Harvest	55 DAT	70 DAT	85 DAT	Harvest
Replication	2	9.672	3.124	17.697	4.789	0.031	0.164	0.372	1.041
Seedling Age (A)	2	2439.595 **	2174.127**	2087.155**	1363.214**	10.004**	9.551**	7.359**	8.068**
Variety (B)	3	362.809**	115.805 **	15.969^{NS}	549.039**	5.564**	0.688^{NS}	0.035^{NS}	0.201^{NS}
A×B	6	34.796 **	55.528**	32.903*	110.572**	1.963*	0.406^{NS}	0.689*	0.382^{NS}
Error	22	4.160	5.989	6.342	7.397	0.538	0.274	0.236	0.263
Total	35								

**: Significance at 1 % level
*: Significance at 5 % level
NS: Non-significance