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Impact of Age and Storage Duration of Seedling on Yield and Yield Attributes of Wet Season Rice

P. Saha[1], M. S. U. Bhuiya[2], B. Karmakar[3*], M. Salim[2], B. Ahmed[1], P. Shil[4] and S. K. Roy[5]

[1&3]Bangladesh Rice Research Institute, Gazipur (17 01), Bangladesh.
[2]Bangladesh Agricultural University, Mymensingh (22 02), Bangladesh
[4]Agriculture Studies, Khulna Government Model School and College, Boyra, Khulna (90 00), Bangladesh
[5]Agriculture Studies, Khulna Public College, Boyra, Khulna (90 00), Bangladesh

Corresponding Author

B. Karmakar
e-mail: biswajitbrri@gmail.com

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Abstract

Yield and yield components of wet season rice are highly depends on age and storage duration of seedling. Sometimes, farmers are compelled to transplant aged and stored seedlings due to natural calamities like flash flood, flood, drought etc. An experiment was conducted in Agronomy Field, Bangladesh Agricultural University, Mymensingh during July to December 2013 to determine the effect of age and storage duration of seedling on yield and yield components of transplant *aman* rice. BRRI dhan 52 was used in the experiment. Four seedling age (25, 30, 35 and 40-d old) and four storage durations of uprooted seedlings (0, 1, 2 and 3-d) were laid out in split-plot design with 3 replications. Seedling age, storage duration and their interaction were significant on yield and yield contributing characters such as panicles m^{-2}, grains panicle^{-1}, panicle length, plant height, tillers hill^{-1} and harvest index. Grain yield gradually decreased along with increased seedling age and storage duration. Seedlings of 25-d-old with 0-d storage duration produced the highest grain yield (6.35 t ha^{-1}) that was at par with 1-d storage seedling (6.15 t ha^{-1}) and thereafter yield reduced dramatically. The highest harvest index (47.1%) was found when 25-d-old seedlings were transplanted and the lowest harvest index (46.5%) was obtained in 40-d-old seedlings. Therefore, 25-d-old seedlings stored up to 1-d after uprooting would be suggested for transplanting to obtain better performance of wet season rice.

Keywords: Seedling age, panicle, grain yield, harvest index

1. Introduction

Seeding age at transplanting is one the most important factors that substantially influences yield and other agronomic parameters (Karmakar and Sarkar, 2015). Seedling age of wet season (*aman*) rice is very important especially for stress prone area like flood and flash flood prone environment. Storage duration of uprooted seedlings is another burning issue for getting higher yield of wet season rice in flash flood and flood affected area. Farmers of these environments could not grow seedlings due to lack of nursery bed. Sometimes, nursery beds become damaged by excess water of flood or flash flood. Wet season rice covers the largest area of 5.60 mha (49.08% of the total rice area) and contributes to 38.10% (12.89 mt) of the total rice production in Bangladesh (BBS, 2013). Bangladesh is one of the most important rice growing countries of the world. Bangladesh ranks the fourth among the rice producing countries of the world following China, India and Indonesia (FAO, 2009; BRRI, 2015). However, the cultivable area is decreasing day by day due to the increasing population so that food security has been and will remain a major concern for Bangladesh. Natural calamities like flood, flash flood, and drought are always threat to rice production and it depends on the magnitude and frequency of hazards. Seedlings damage due to early or flash flood is very common feature in Bangladesh. Consequently, farmers suffer from the shortage of seedlings or compelled to transplant aged or too young seedlings when the floodwater recedes. As a result, seedlings limitation is a severe problem in this situation. At that time, rice seedlings of optimum age may be required to transport to the flood affected area from the nearby districts which may take 2 to 3 days. So, the optimum age and storage duration of uprooted seedling may contribute significantly yield and yield components of transplant *aman* rice. Therefore, the present study was undertaken to determine the optimum age of seedlings for wet season rice and investigate the storage effects of different aged seedlings on yield and yield components of wet season rice.

2. Materials and Methods

The experiment was conducted at the Agronomy field laboratory of Bangladesh Agricultural University, Mymensingh (24°75′ N latitude and 90°50′ E longitude at an elevation of 18 m above the sea level) during wet season (*Aman*) from July to December 2013. The soil of the experimental plot belongs non-calcareous dark grey flood plain type under the old Brahmaputra Alluvial Floodplain. The land was medium high with sandy loam texture having a soil pH 7.2 (BARC, 2012). The experimental field is situated under sub-tropical climate where usually the rainfall is heavy during April to September. A high yielding submergence tolerant rice variety, BRRI dhan52 was used in the experiment. The experiment consisted of two factors like seedling age (25, 30, 35 and 40-d-old seedlings) and storage duration of seedling after uprooting (0, 1, 2, and 3 days). The experiment was laid out in a split-plot design with 3 replications assigning seedling age in the main plots and storage duration in the sub-plots. The sprouted seeds were sown in the wet nursery bed on four dates viz., 26 June, 1st July, 6th July and 11th July in 2013. Proper care was taken to raise the seedlings in the seedbed. Weeds were removed and irrigation was given in the nursery bed as and when necessary. The experimental land was prepared in puddle condition through plowing and cross plowing four times with a country plough followed by laddering to level the soil. The fertilizers urea, triple super phosphate (TSP), muriate of potash (MOP) and gypsum were applied experimental plots @ 195, 52, 82 and 60 kg ha^{-1}, respectively (BRRI, 2011). The entire amounts of TSP, MOP and gypsum were applied as basal dose at the time of final land preparation. Urea was top dressed in three equal splits at 15, 35 and 50 days after transplanting (DAT). The nursery bed was made wet by applying water on the previous days before uprooting the seedlings. The seedlings were uprooted carefully from nursery bed on 2, 3, 4 and 5 August 2013 without causing much mechanical injury to the roots to get 40, 35, 30 and 25 -d-old seedlings for transplanting. The uprooted seedlings were stored separately on the shade before transplanting for 3, 2, 1 and 0 day, respectively, as per treatments. Seedlings of 40, 35, 30 and 25 days with the combination of storage duration of 3, 2, 1 and 0 days were transplanted in the main field in same day on 5 August, 2013 with 3 seedlings hill^{-1} at 25x15 cm^2 spacing. The crop was infested by rice stem borer which was controlled by applying Diazinon 60 EC as per recommendation of BRRI (2011). Uniform management practices were followed for all the treatments. Twelve hills were harvested diagonally in each plot to record the data on yield components. From center of each plot, six square meter area was harvested to record yield on 24 November 2013 at maturity. Grain and straw yield was adjusted to 14 and 3% moisture content, respectively and converted to t ha^{-1} (Karmakar and Sarkar, 2015). The collected data were statistically analyzed using MSTAT. The significance of mean differences among the treatments was adjudged by Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) Test (Gomez and Gomez, 1984).

3. Results and Discussion

3.1. Effect of seedling age and storage duration on yield and yield contributing characteristics

3.1.1. Grain yield

Grain yield was significantly influenced by seedling age (Table 1). These findings are in conformity with Karmakar and Sarkar, 2015; Hussain et al., 2012; Krishna and Patil, 2009. The highest grain yield (5.52 t ha^{-1}) was observed when 25-d-old seedlings were transplanted and the lowest grain yield (4.02 t ha^{-1}) was obtained from 40-d-old seedlings (Table 1). Similar result was also reported by Sarkar et al. (2011) with the transplanting of 25-d-old seedlings. Grain yield exhibited a regular trend of decrease with the increase in seedling age. This finding was supported by Upadhyay et al. (2003) and Singh and Singh (1998). Older seedlings remained more days in the nursery bed. As a result basal node appeared in the seedlings. Again it took more time to establish in the main field. On the contrary, the younger seedlings got less time in the nursery bed for node formation and quickly they recovered the transplanting shock in the main field. Thus they start re-growth quickly

Table 1: Effect of seedling age on yield and yield attributes of wet season rice

Seedling age (day)	Grain yield (t ha^{-1})	Panicles hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Spikelet sterility (%)	1000-grain wt (g)	Harvest index (%)	Plant height (cm)
A_1	5.52	8.7	25.8	119	15.8	21.6	47.1	114
A_2	4.87	7.6	25.6	116	17.4	20.7	46.7	110
A_3	4.62	7.0	24.8	110	21.2	20.5	46.2	106
A_4	4.02	5.9	23.3	105	22.9	19.2	46.0	106
$LSD_{0.05}$	0.09	0.6	0.78	2	0.44	-	0.7	1
F-test	**	**	**	**	**	ns	**	**

In a column, figures having common letter(s) do not differ significantly whereas the figures with dissimilar letters differ significantly as adjusted by DMRT; *: Significant at (p=0.05) level of probability; **: Significant at (p=0.01) level of probability; ns: Not significant; A_1: 25; A_2: 30; A_3: 35; A_4: 40-d old seedling which ultimately helped to work in favor of better growth of plant, yield components and yield. These findings are in good harmony with Karmakar and Sarkar (2015) who reported that younger seedlings could able to mitigate the transplanting shock within a shorter period of time compared to older seedlings. Moreover, panicle initiation started earlier and more spikelets formed in the plants of younger seedlings. Thus the yield components were improved and sterility percentage was decreased which were mainly responsible for the improvement of grain yield of the younger seedlings (Karmakar and Sarkar, 2015; Hussain et al., 2012; Krishna et al., 2008). Grain yield was significantly affected by the storage duration of uprooted seedlings (Table 2). The highest grain yield (5.31 t ha^{-1}) was observed with 0 day storage duration which was statistically identical (5.04 t ha^{-1}) with 1 day storage duration but significantly different from other treatments and the lowest grain yield (4.04 t ha^{-1}) was obtained with 3 days storage duration (Table 2). Similar findings were also reported by Kaykobad (2001) and Islam (1995). Grain yield exhibited a regular trend of decrease with the increase in storage durations of uprooted rice seedlings from 0 to 3 days. It is to be noted that the fresh seedlings (0 and 1 day storage duration) transplanted without a mentionable delay gave the highest grain yield. The delay in transplanting of uprooted seedlings decrease the grain yield significantly. Similar results found by Karim (2007) who reported that uprooted seedlings were found to be storable up to 2 days without any significant loss of grain yield. The production of the maximum grain yield with 0 day storage duration might have been the cumulative results of the favorable effects of number of effective tillers hill^{-1} and no. of grains panicle^{-1}. The seedlings stored for 0 and 1 day i.e. freshly uprooted seedlings virtually did little suffer from any kind of stresses like reestablishment, nutrient uptake or other unfavorable situations due to uprooting as experienced by those stored for longer period from uprooting to transplanting. Grain yield was significantly influenced by the interaction between the age and storage duration of uprooted seedlings (Table 3). The highest grain yield (6.35 t ha^{-1}) was obtained from 25-d-old seedlings with 0 day storage duration and the lowest grain yield (3.38 t ha^{-1}) was observed in 40-d-old seedlings with 3 days storage duration (Table 3). The highest grain yield might be the contribution of more numbers of effective tillers hill^{-1} and grains panicle^{-1}.

Table 2: Effect of storage duration of seedling on yield and yield attributes of wet season rice

Seedling age (day)	Grain yield (t ha^{-1})	Panicles hill^{-1} (no.)	Panicle length (cm)	Grains panicle^{-1} (no.)	Spikelet sterility (%)	1000-grain wt (g)	Harvest index (%)	Plant height (cm)
D_1	5.31	9.6	25.2	125	15.0	20.8	47.3	111
D_2	5.04	8.8	24.9	117	16.3	20.5	46.5	110
D_3	4.64	6.4	24.8	106	22.2	20.5	46.3	110
D_4	4.04	4.4	24.4	101	23.8	20.2	45.2	107
$LSD_{0.05}$	0.11	0.5	-	2	0.6	-	1.0	2
F-test	**	**	ns	**	**	ns	*	**

In a column, figures having common letter(s) do not differ significantly whereas the figures with dissimilar letters differ significantly as adjusted by DMRT; *=Significant at (*p*=0.05) level of probability; **: Significant at (*p*=0.01) level of probability; ns: Not significant; D_1: 0, D_2: 1; D_3: 2; D_4: 3 days storage duration

3.1.2. Plant height

Plant height at harvest was significantly affected by seedling age (Table 1). The tallest plant (114 cm) was found when 25-d-old seedlings were transplanted. The tallest plant was found in the crop of 25 -d-old seedlings due to early recovery of transplanting shock and better growth of the plants. Similar result was also reported by Sarkar et al. (2011). The shortest plant (106 cm) was obtained when 40-d-old seedlings were transplanted. Plant height exhibited a trend of decrease with the increase in seedling age. Plant height was significantly affected by the storage duration of uprooted seedling. The tallest plant (111 cm) was found with 0 day storage duration and the shortest plant (107 cm) was obtained with 3 days of storage duration (Table 2). This finding was justified by Kaykobad (2001). Plant height exhibited a trend of decrease with the increase in storage durations of uprooted rice seedlings from 0 to 3 days. This is due to the decrease in plant vigor with the increase in storage durations. Plant height varied slightly due to the interaction between the age and storage duration of uprooted seedlings and the differences among themselves were not enough to be significant. But numerically, the highest plant height (116 cm) was obtained in 25-d-old seedlings with 0 day storage duration and the lowest plant height (104 cm) was obtained in 35-d-old seedlings with 3 days storage duration (Table 3).

3.1.3. Panicle production

No. of panicles hill^{-1} was significantly affected by seedling age (Table 1). Younger seedlings produced more panicles per unit area compared to older seedlings (Pasuquin et al., 2008; Karmakar and Sarkar, 2015). The maximum no. of panicles hill^{-1} (8.8) was obtained when 25-d-old seedlings were transplanted and the minimum no. of panicles hill^{-1} (5.9) was observed when 40-d-old seedlings were transplanted. No. of panicles

Age of seedlings ×storage duration	Grain yield (t ha^{-1})	Panicles $hill^{-1}$ (no.)	Panicle length (cm)	Grains pan-$icle^{-1}$ (no.)	Spikelet sterility (%)	1000-grain wt (g)	Harvest index (%)	Plant ht. (cm)
A_1×D_1	6.35	10.3	27.2	139	11.0	23.0	48.1	116
A_1×D_2	6.15	10.2	27.0	122	13.5	21.0	46.7	114
A_1×D_3	5.53	8.3	24.8	107	21.3	21.2	45.1	116
A_1×D_4	4.54	6.2	24.3	108	17.5	21.1	48.6	111
A_2×D_1	5.78	10.2	26.1	131	14.0	21.0	47.9	111
A_2×D_2	5.03	10.0	25.4	127	13.3	18.5	45.7	112
A_2×D_3	4.68	5.4	24.2	105	19.0	18.7	44.6	109
A_2×D4	4.27	4.8	25.7	101	23.4	18.7	48.5	109
A_3×D_1	4.87	9.0	23.3	127	16.0	20.8	46.2	110
A_3×D_2	4.81	9.1	25.4	107	19.6	21.1	46.5	106
A_3×D_3	4.84	6.4	26.1	108	22.9	21.2	48.0	106
A_3×D_4	3.95	3.3	24.3	97	26.3	21.4	47.1	104
A_4×D_1	4.54	9.0	24.0	103	19.0	21.1	46.8	107
A_4×D_2	4.37	5.7	21.8	113	19.0	20.4	46.0	106
A_4×D_3	3.79	5.5	24.3	105	25.6	20.8	45.5	108
A_4×D_4	3.38	3.5	23.3	98	27.9	18.2	44.7	104
$LSD_{0.05}$	0.21	1.1	1.1	3	1.3	0.2	2.0	-
F-test	**	**	**	**	**	*	**	ns

Table 3: Interaction effects of age and storage duration of seedling on yield and yield attributes of wet season rice

In a column, figures having common letter(s) do not differ significantly whereas the figures with dissimilar letters differ significantly as adjusted by DMRT; *: Significant at (p=0.05) level of probability; **: Significant at (p=0.01) level of probability; ns: Not significant; A_1: 5; A_2: 30; A_3: 35; A_4: 40-d old seedling; D_1: 0; D_2: 1; D_3: 2; D_4: 3 days storage duration

$hill^{-1}$ was gradually decreased as the age of seedling increased. The results are in conformity with the findings of Hussain et al., 2012; Haque (2002). No. of panicles $hill^{-1}$ was significantly affected by storage duration of uprooted seedling. The maximum no. of panicles $hill^{-1}$ (9.6) was obtained with 0 day of storage duration and the minimum no. of panicles $hill^{-1}$ (4.4) was with 3 days of storage duration. Similar finding was also found by Islam (1995). The no. of panicles $hill^{-1}$ exhibited a trend of decrease with the increase in storage durations of uprooted seedlings from 0 to 3 days (Table 2). Panicles $hill^{-1}$ was significantly influenced by the interaction between the age and storage duration of uprooted seedlings. The maximum no. of panicles $hill^{-1}$ (10.3) was obtained in 25-d-old seedlings with 0 day storage duration and the minimum no. of panicles $hill^{-1}$ (3.3) was found in 35-d-old seedlings with 3 days storage duration (Table 3).

3.1.4. Panicle length

Panicle length was significantly affected by seedling age (Table 1). The longest panicle (25.8 cm) was found when 25-d-old seedlings were transplanted. The longest panicle was found in the crop of 25-d-old seedlings due to longer period from initiation to emergence as well more vigor of plants. Similar result was reported by Sarkar et al. (2011). The shortest panicle (23.3 cm) was found when 40-d-old seedlings were transplanted. Panicle length exhibited a trend of decrease with the increase in seedling age. Panicle length varied slightly due to the storage duration of uprooted seedlings and the differences among themselves were not enough to be significant. But numerically, the longest panicle (25.2 cm) was obtained with 0 day storage duration and the shortest panicle (24.4 cm) was found with 3 days storage duration (Table 2). This result was justified by Das and Mukherjee (1992). Panicle length was significantly influenced by the interaction between the age and storage duration of uprooted seedlings. The longest panicle (27.2 cm) was obtained in 25-d-old seedlings with 0 day storage duration and the shortest panicle (21.8 cm) was found in 40-d-old seedlings with 1 day storage duration (Table 3).

3.1.5. Grains $panicle^{-1}$

Seedling age had significant effect on grains production $panicle^{-1}$ (Table 1). The highest no. of grains $panicle^{-1}$ (119) was found when 25-d-old seedlings were transplanted while the lowest grains $panicle^{-1}$ (105) was obtained in 40-d-old seedlings. No. of grains $panicle^{-1}$ exhibited a trend of decrease with the increase in seedling age. This finding was also supported by Yoshii and Sandier (1998). Younger seedlings produce more grains panicle^{-1} than the older ones due to longer vegetative period of younger seedlings. The results are corroborating with the findings of Sarwa et al., 2011. No. of grains panicle^{-1} was significantly affected by the storage duration of uprooted seedling. The highest no. of grains panicle^{-1} (125) was found with 0 day storage duration followed by 1 day storage (117) and the lowest grains panicle^{-1} (101) was obtained with 3 days storage duration (Table 2). Similar result was also obtained by Kaykobad (2001). No. of grains panicle^{-1} exhibited a trend of decrease with the increase in storage durations of uprooted rice seedlings from 0 to 3 days. This is due to the decrease in plant vigor with the increase in storage durations. Interaction age and storage duration of uprooted seedlings had also significant effect on grains panicle^{-1} (Table 3). The highest no. of grains panicle^{-1} (139) was obtained in 25-d-old seedlings with 0 day storage duration while the lowest grains panicle^{-1} (97) was found in 35-d-old seedlings with 3 days storage duration (Table 3).

3.1.6. Spikelet sterility

Sterility percentage was significantly affected by seedling age (Karmakar and Sarkar, 2015; Hussain et al., 2012; Mishra and Salokhe, 2008). The highest sterility percentage (22.9 %) was found when 40-d-old seedlings were transplanted and the lowest sterility percentage (15.8%) was obtained when 25-d-old seedlings were transplanted (Table 1). Sterility percentage increased with the increase in seedling age. This finding was justified by Yoshii and Sandier (1998). Sterility percentage was significantly affected by the storage duration of uprooted seedling. The highest sterility percentage (23.8 %) was found with 3 days storage duration and the lowest sterility percentage (15.0%) was obtained with 0 day storage duration (Table 2). This finding was supported by Kaykobad (2001). Sterility percentage exhibited a trend of decrease with the increase in storage durations of uprooted rice seedlings from 0 to 3 days. Sterility percentage was significantly influenced by the interaction between the age and storage duration of uprooted seedlings (Table 3). The highest sterility percentage (27.9%) was obtained in 40-d-old seedlings with 3 days storage duration and the lowest sterility percentage (10.9%) was found in 25-d-old seedlings with 0 day storage duration (Table 3).

3.1.7. Thousand grain weight

Weight of 1000 grains was not significantly affected by seedling age (Table 1). These findings are in conformity with the findings of Faghani et al. (2011) and Faruk et al. (2009) who found that seedling age had no significant effect on grain weight. But numerically, the maximum 1000-grain weight (21.6 g) was obtained in 25-d-old seedlings and the minimum 1000-grain weight (19.2 g) was found in 40-d-old seedlings (Table 1). Similar findings were also observed by Roy et al. (1992). Weight of 1000 grains varied slightly due to the storage duration of uprooted seedlings and the differences among themselves were not enough to be significant. But numerically, the maximum 1000-grain weight (20.8 g) was obtained with 0 day storage duration and the minimum of 1000-grain weight (20.2 g) was found with 3 days storage duration (Table 2). Similar finding was also found by Das and Mukherjee (1992). Weight of 1000 grains was significantly influenced by the interaction between the age and storage duration of uprooted seedlings. The maximum 1000-grain weight (22.97 g) was obtained in 25-d-old seedlings with 0 day storage duration and the minimum weight of 1000 grains (18.22 g) was found in 40-d-old seedlings with 3 days storage duration (Table 3).

3.1.8. Harvest index

Harvest index was significantly affected by seedling age (Table 1). The highest harvest index (47.1 %) was found when 25-d-old seedlings were transplanted and the lowest harvest index (46.5%) was obtained when 40-d-old seedlings were transplanted (Table 1). Similar findings were also observed by Singh and Singh (1998). Harvest index was significantly affected by storage duration of uprooted seedling (Table 2). The highest harvest index (47.3%) was found with 0 day storage duration and the lowest harvest index (46.3%) was obtained with 2 days storage duration (Table 2). This finding was supported by Kaykobad (2001). Harvest index was significantly influenced by the interaction between the age and storage duration of uprooted seedlings (Table 3). The highest harvest index (48.6%) was obtained in 25-d-old seedlings with 3 days storage duration and the lowest harvest index (44.6%) was observed in 30-d-old seedlings with 2 days storage duration (Table 3). The results indicate that growth attributes as well as yield contributing characters especially grain and straw yield were gradually decreased with the increase in seedling age ranging from 25 to 40-d-old. From the results of the present study, it also appears that the storage duration of uprooted seedlings has profound influence on grain and straw yield of the transplanted *aman* rice. The yield gradually decreased with the increase in storage duration. The highest grain and straw yield was obtained from 25-d-old seedlings with 0 day storage duration.

4. Conclusion

Seedlings of 25-d-old with 0 day storage performed the best followed by 1 day stored seedlings. Yield gradually decreased with increased seedling age from 25 to 40 days with storage durations ranging from 0 to 3 days. Considering the possible delay in transporting of seedlings from the nearby districts to the flood affected area, it could be concluded that 25-d-old seedlings may be kept stored up to 1 day after uprooting to get better performance.

5. References

BARC (Bangladesh Agricultural Research Council), 2012. Fertilizer Recommendation Guide. Published by BARC, Farm gate, Dhaka, 1–257.

BBS (Bangladesh Bureau of Statistics), 2013. Monthly

Statistical Bulletin of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Min. Plan., Govt. of People's Repub. of Bangladesh, Dhaka, 71.

BRRI (Bangladesh Rice Research Institute), 2011. *Adhunik Dhaner Chash* (Cultivation of Modern Rice), Gazipur, Bangladesh, 5–28.

BRRI (Bangladesh Rice Research Institute), 2015. *Adhunik Dhaner Chash* (Cultivation of Modern Rice), Gazipur, Bangladesh, 5–23.

Das, N.R., Mukherjee, N.N., 1992. Effect of seedlings uprooting time and leaf removal on grain and straw yields of rainy season rice *(Oryza sativa* L.). Indian Journal of Agronomy 37(1-2), 167–169.

Faghani, R., Mobasser, H.R., Dehpor, A.A., Kochaksarai, S.T., 2011. The effect of planting date and seedling age on yield and yield components of rice (*Oryza sativa* L.) varieties in North of Iran. African Journal of Agricultural Research 6(11), 2571–2575.

FAO (Food and Agricultural Organization), 2009. Production Year Book. Food and Agric. Org. of the United Nations, Rome, Italy 45, 72–73.

Faruk, M.O., Rahman, M.A., Hasan, M.A., 2009. Effect of seedling age and no. of seedling per hill on the yield and yield contributing characters of BRRI dhan33. International Journal of Sustainable Crop Production 4(1), 58–61.

Gomez, K.A., Gomez, A.A., 1984. Statistical procedure for Agril. Res. Intl. Rice Res. Inst., John Wiley and Sons. New York, Chichester, Brisbane, Toronto, Singapore. pp. 139–240.

Haque, D.E., 2002. Effect of Madagascar technique of younger seedling and wider spacing on growth and yield of *Boro* rice. MS Thesis, Dept. Agron., Bangladesh Agricultural University,, Mymensingh, 28–71.

Hussain, A., Bhat, M.A., Ganie, M.A., 2012. Effect of no. and age of seedlings on growth, yield, nutrient uptake and economics of rice (*Oryza sativa*) under system of rice intensification in temperate conditions. Indian Journal of Agronomy 57(2), 133–137.

Islam, M.S., 1995. Effect of variety and storing time of seedlings on the yield of Boro rice. MS Thesis, Dept. Agron., Bangladesh Agricultural University, Mymensingh, 6.

Karim, S.M.R., 2007. Effect of storage conditions and durations of uprooted seedlings on the performance of aromatic rice. MS Thesis, Dept. Agron., Sher-e-Bangla Agricultural University, Dhaka, Bangladesh, 5–60.

Karmakar, B., Sarkar, M.A.R., 2015. Optimizing seedling age of promising rice genotypes in rainfed environment. Journal of Crop and Weed 11**,** 149–160.

Kaykobad, S.A.M., 2001. Effect of storage conditions and storage durations of uprooted seedlings on the yield and yield contributing characters of transplant aman rice cv. Binashail. MS Thesis, Dept. of Agronomy., Bangladesh Agricultural University, Mymensingh, 36.

Krishna, A., Patil, N.K.B., 2009. Influence of seedling age and spacing on seed yield and quality of short duration rice under system of rice intensification cultivation. Karnataka Journal of Agricultural Science 22(1), 53–55.

Krishna, A., Patil, N.K.B., Manjappa, K., Channappagoudar, B.B., 2008. Evaluation of system of rice intensification cultivation, seedling age and spacing on seed yield and quality in Samba Masuhri (BPT-5204). Karnataka Journal of Agricultural Science 21(1), 20–25.

Mishra, A., Salokhe, V.M., 2008. Seedling characteristics and the early growth of transplanted rice under different water regimes. Experimental Agriculture 44, 1–19.

Pasuquin, E., Lafarge, T., Tubana, B., 2008. Transplanting young seedlings in irrigated rice fields: Early and high tiller production enhanced grain yield. Field Crops Research 105(1-2), 141–155.

Roy, B.C., Sattar, S.A., Gaffer, M.A., Islam, M.A., 1992. Seedling age effect on yield of irrigated rice. Bangladesh Rice Journal 3(1&2), 83–84.

Sarkar, M.A.R., Paul, S.K., Hossain, M.A., 2011. Effect of row arrangement, age of tiller seedlings and no. of tiller seedlings hill^{-1} on performance of transplant *aman* rice. Journal of Agricultural Science 6(2), 59–68.

Sarwa, N., Maqsood, M., Wajid, S.A., Haq, M.A.U., 2011. Impact of nursery seeding density, nitrogen, and seedling age on yield and yield attributes of fine rice. Chilean Journal of Agricultural Research 71(3), 343–349.

Singh, R.S., Singh, S.B., 1998. Response of rice *(Oryza sativa* L.) to age of seedlings and level and time of application of nitrogen under irrigated condition. Indian Journey Agronomy 43(4), 632–635.

Upadhyay, V.V., Mathew, R., Vishwakarma, S.K., Shukla, V.K., 2003. Effect of no. of seedlings per hill and age of seedlings on productivity and economics of transplanted rice. JNKVV. Research Journal 37(1), 27–29.

Yoshii, L.N., Sandier, P.A., 1998. Effect of seedling age, spacing and date of transplant on yield of rice in China. China Rice 5(26), 28–36.