J Agric Rural Dev Volume14(1&2):1-11, December 2022 *ISSN 1810-1860*

SCHOOL OF AGRICULTURE AND RURAL DEVELOPMENT
কৃষি ও পল্লী উন্নয়ন স্কুল

JARD
Journal of Agriculture & Rural Development

Effect of crop establishment method and weed management practices on the performance of T. *aman* rice

M.A. Salam*, M.D. Hossain, M.L. Mia, K.A.M. Onna, M. Begum

Department of Agronomy, Faculty of Agriculture, Bangladesh Agricultural University, Mymensingh- 2202, Bangladesh

ABSTRACT

An experiment was conducted in the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during July to November 2019 to study the effect of crop establishment method and weed management on the yield of BRRI dhan58. There were two rice establishment methods and seven weed management practice as treatment variables. The experiment was laid out in a split plot design assigning crop establishment methods in the main plots and weed management practices in the sub-plots with three replications. Fourteen weed species infested the experimental field belonging to six families. Among the weed species, five were grasses, four broad leaves and five sedges. Data were collected at different growth stages and at harvest. The highest grain yield (6.43 t ha^{-1}) and straw yield (7.25 t ha^{-1}) were obtained from the interaction of puddle transplanting method with application of pre-emergence herbicide Commit (Pretilachlor) followed by one hand weeding at 35 DAT, which was followed by the interaction of puddle transplanting method with two hand weeding at 15 and 35 DAT. The lowest yield was obtained when there was no weeding in unpuddle transplanting method. Therefore, puddle transplanting with application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT might be recommended for controlling weed effectively and maximizing the yield of transplant aman rice.

Key words: agricultural practices, crop establishment method, crop management, crop performance, crop yield, farming techniques

INTRODUCTION

Transplant *aman* covers the largest area; it occupies about 49% of total cultivable land area (BBS, 2020). *Aman* is the second largest rice-crop in the country in respect to volume of production, while *boro* remains the top (Khan *et al.,* 2020). The area coverage of *aman* rice is the largest as a single crop and cultivation of *aman* rice covers approximately 50.56% of the country's total cultivated land area for rice production (Sayeed and Yunus, 2018).

Traditionally rice is grown by manual transplanting of 25-30 days old seedling after puddling in T. *aman* season. Puddling in the field and continuous standing water lead to nutrient losses through leaching. Though puddling has a great impact in controlling weeds and easy transplantion, however it creates soil physical condition detrimental to the following crop in rice-based cropping systems (Bhuyan *et al.,* 2012). Besides, puddle transplanting consumes about 20-40% of the total water required for raising crops. It also promotes the formation of hardpan (Kalita *et al.,* 2020). To overcome these problems, adoption of unpuddle transplanting might be a perfect alternative to puddle transplanting as it is using widely for many crops around the world (Singh *et al.,* 2014).

Among the various factors reducing the rice yield, weeds are considered as the major constraint (Fahad *et al.,* 2019). There is no way to get maximum benefit from the rice field without

* Corresponding author: salamma71@yahoo.com

keeping the land free from weed infestation. Hand weeding is generally practiced in major rice cultivation in Bangladesh (Ashraf, 2021). But weed control is often imperfect or delayed due to unavailability of labour during the peak period. So, the hand weeding method has become costly and being more difficult day-by-day due to the scarcity of labor (Rahman, 2014). The weed pressure during crop establishment is low in the puddle transplanted system, but weed is the major barrier in unpuddle transplanted rice. Long-term studies indicate that zero or minimum soil disturbance either improves or maintains soil fertility and productivity and similarly increases (Li *et al.,* 2007) or gives similar (Bell *et al.*, 2017) crop yields in comparison with conventional cropping systems. Islam *et al.* (2014) reported that in wet season, bed planting and strip tillage under unpuddle condition saved fuel and water usage by 31-76% and 25-26% compared to conventional tillage, respectively. Currently, numerous pre-emergence herbicides are effective in controlling weeds when used together with hand weeding (Ahmed *et al.,* 2003). Minimum tillage also saved about 30-54% fuel consumption and 40-49% labor requirement compared to conventional tillage in land preparation (Gathala *et al.,* 2016) considering the above factors. The present study was, undertaken to analyze the effect of methods of crop establishment and weeding on the yield of transplant *aman* rice.

MATERIALS AND METHODS

Experimental site and design

The experimental field belongs to the non-calcareous dark grey flood-plain soil under the Agro-ecological Zone of the Old Brahmaputra Floodplain (AEZ-9). The experiment was laid out in a split plot design assigning crop establishment methods in main plots and weed management practices in the sub-plots with three replications. There were 14 treatment combinations. Thus, total number of plots was (2 x 7 x 3) = 42. Each plot size was 10 m^2 (4 m x 2.5 m). The distance between block to block and plot to was 1.5 m and 1 m, respectively.

Experimental treatment

The study consisted of the following factors and treatments. Factor A: Two rice establishment methods, namely Unpuddle transplanting (M_1) and Puddle transplanting (M_2). Factor B: Seven weed management practices, *viz*. No weeding (W_0), Two hand weeding at 15 and 35 DATs (W_1), Application of pre-emergence herbicide Commit (Pretilachlor @ 2Lha^{-1}) (W_2), Application of early post emergence herbicide Paddyplus (Acetachlor + Bensulfuron methyl) 18 WP @ 750 gha^{-1} (W_3), Application of pre-emergence herbicide Commit (pretilachlor) followed by early post emergence herbicide Paddyplus (Acetachlor + Bensulfuron methyl) (W_4), Application of pre-emergence herbicide Commit (pretilachlor) followed by one HW at 35 DATs (W_5), Application of early post emergence herbicide Paddyplus (Acetachlor + Bensulfuron methyl) followed by one HW at 35 DATs (W_6)

Description of crop establishment methods

Unpuddle transplanting

No tillage operation was done for unpuddle transplanting. Stubbles and weeds were removed and cleaned from individual plots before transplanting. Water level was maintained 5-7 cm. Then seedling was transplanted in unpuddle field at the rate of two seedlings hill^{-1} maintained row and hill distance of 20 cm and 15 cm, respectively.

Puddle transplanting

In puddle transplanting the plot was opened with a power tiller and subsequently ploughed three times with country plough followed by laddering. In this method seedlings were transplanted in well prepared puddled field at the rate of two seedlings hill^{-1} maintained row and hill distance of 20 cm and 15 cm, respectively. Water level was maintained 5-7 cm.

Description of rice cultivar

BRRI dhan58, a variety of boro rice developed by Bangladesh Rice Research Institute. It is a high yielding variety. It takes about 150 days to mature. It attains a height of 100 cm at maturity. The grain is medium sized and the maximum yield of this variety is 7-7.5 t ha^{-1}. (BRRI, 2018)

Preparation of seedling nursery bed and seed sowing

A piece of land was selected for raising seedlings. The land was puddled with power tiller followed by levelling with ladder. The sprouted seeds were sown in the nursery bed on 5 July 2019 for both puddle and unpuddle transplanting. Proper care was taken to raise the healthy seedling in the nursery bed. Weeds were removed and irrigation was given in the nursery bed as and when necessary.

Main land preparation

The field was prepared by power tiller with three times ploughing and cross ploughing followed by laddering. The layout of the field was made after final land preparation. Stubbles and weeds were removed and cleaned from individual plots.

Fertilizer application

After laying out the land the experimental plots were fertilized with urea, triple superphosphate, muriate of potash, gypsum and zinc sulphate @ 200-70-110-70-10 kg ha^{-1}, respectively (Sharma, 2008). The entire amount of triple superphosphate, muriate of potash, gypsum and zinc sulphate was applied at the time of final land preparation. Urea was applied in three instalments at 7, 21 and 35 days after transplanting (DAT).

Transplanting of seedlings

Twenty-eight-day old seedlings were transplanted in the well-prepared field on 2 August 2019at the rate of two seedlings $hill^{-1}$, maintained row and hill distance of 20 cm and 15 cm, respectively in puddle and unpuddle transplanting method.

General observation of the experimental field

A regular observation was made to ensure better growth of plants for good yield. In the whole period of experiment, the field was green ensuring the normal growth. Insect attack was not observed. Disease infestation was not too severe to cause damage to the crop. Lodging of any plant was not observed.

Harvesting and sampling

Five hills (excluding border hills) were selected randomly from each unit plot and uprooted to record necessary data at 25 DATs and 50 DATs. When 80% of the panicle turned into golden yellow color, the crops were assessed to attained maturity. Five hills were randomly selected for recording data on yield and yield contributing characters. After sampling a harvest area of central 1 m x 1 m was selected from each unit plot. The harvested crop of each unit area was separately bundled, properly tagged and then brought to the threshing floor of the Agronomy Field Laboratory. The grains were cleaned and sun dried to moisture content of 14%. Straw was also dried properly. Finally grain and straw yields per plot were recorded and converted to ha^{-1}.

Data collection and statistical analysis

Data on different growth parameters, yield and yield contributing characters were recorded. Data were compiled and tabulated in proper form for statistical analysis. The recorded data were statistically analyzed following 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 namely, MSTAT-C.

RESULTS AND DISCUSSION

Effect of crop establishment method on growth and yield of T. *Aman* rice

The plant height was not significantly affected by different crop establishment methods. Numerically the taller plant (101.01cm) was found in puddle transplanting method and the shorter plant (100.7cm) was found in unpuddle transplanting method (Figure 1A). Similar research finding was also reported by Nagarjana *et al*. (2021) who showed that plant height in dry seeding on puddled soil was superior over rest of the treatments. Number of total tillers hill^{-1} was significantly influenced by different crop establishment methods. The higher number of total tillers (8.97) and effective tillers (7.98) hill^{-1} was observed in puddle transplanting method and the lower one was observed in unpuddle transplanting method (Figure 1B and 1C). Similar research finding was reported by Afrina *et al.* (2019) who reported that puddle transplanted rice produced significantly higher number of tiller than other establishment methods. This might be due to the fact that puddle transplanting helped to destroy standing weeds in rice field at the early stage of crop growth by burying weed seeds into the puddle land and hence higher number of tillers was produce (Rahman, 2016).The longer panicle (22.65 cm) was produced in puddle transplanting method and the shorter one (22.15 cm) was produced in unpuddle transplanting methods of crop establishment (Figure 1D). Similar research finding was also reported by Farhat *et al.* (2023). Number of grains panicle^{-1} was significantly influenced by different crop establishment methods. The higher number of grains panicle^{-1} (98.85) was observed in puddle transplanting method and the lower one (91.98) was found in unpuddle transplanting method (Figure 1E).Puddle transplanting probably helped to destroy standing weeds in rice field at the early stage of crop growth by burying weed seeds into the puddle field. As a results vigorous rice growth happened in puddle transplanting and hence higher number of grains panicle^{-1} was produced. Similar research findings were also reported by Ali *et al*. (2018) and Rahman *et al.* (2020a) who reported that transplanted puddled rice produced higher number of grains panicle^{-1} among other crop establishment methods.

Weight of 1000-grain was not significantly influenced by different crop establishment methods. Numerically the highest 1000-grain weight (22.03 g) was found in puddle transplanting method while the lowest one (21.95 g) was in unpuddle transplanting method (Figure 2A). Different crop establishment methods had significant effect on grain yield. The highest grain yield (5.78 t ha^{-1}) was found in puddle transplanting method and the lowest grain yield (5.35 t ha^{-1}) was in unpuddle transplanting method (Figure 2B).Puddle transplanting probably helped to destroy standing weeds in rice field at the early stage of crop growth by burying weed seeds into the puddle field. As a results vigorous rice growth happened in puddle transplanting and hence higher number of effective tillers hill^{-1} and higher number of grains panicle^{-1} was produced which ultimately enhanced rice grain yield. Similar research findings were also reported by Ali *et al*. (2018), Islam *et al*. (2023) and Nagarjuna *et al.* (2021), who pointed out that puddle transplanting produced higher grain yield than other crop establishment methods. Numerically the higher straw yield (6.60 t ha^{-1}) was found in puddle transplanting method and the lower one (6.26 t ha^{-1}) was found in unpuddle transplanting method (Figure 2C). The highest biological yield (12.39 t ha^{-1}) was obtained in puddle transplanting method and the lowest (11.62 t ha^{-1}) was obtained in unpuddle transplanting method (Figure 2D). Harvest index was significantly affected by crop establishment method. The highest harvest index (46.62%) was found in puddle transplanting method and the lowest one (45.86%) was found in unpuddle transplanting method (Figure 2E).

Effect of weed management practices of growth and yield of T. *Aman* rice

Plant height was significantly affected by different weed management practices. The tallest plant (102.11cm) was found in W_1 (Two hand weeding at 15 and 35 DATs) which was statistically similar to W_4 (Application of pre-emergence herbicide Commit followed by early post-emergence herbicide Paddyplus) and W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT). The shortest plant (97.11cm) was found in W_0 (No weeding) treatment (Figure 3A). Number of total and effective tillers hill^{-1} was significantly influenced by different weeding treatments. The higher number of total (9.83) and effective tillers (8.85) hill^{-1} was observed in W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment. The lowest number of total (6.59) and effective tillers (5.43) hill^{-1} was observed in W_0 (No weeding) treatment (Figure 3B, 3C). Weed management practices had significant influence on panicle length. The longest panicle (22.86 cm) was observed in W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment and the smallest one (21.82

cm) was observed in W_0 (no weeding) treatment (Figure 3D).The highest number of grains panicle^{-1} (105.52) was observed in W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment, while the lowest number of grains panicle^{-1} (79.58) was observed in W_0 (No weeding) treatment (Figure 3E).

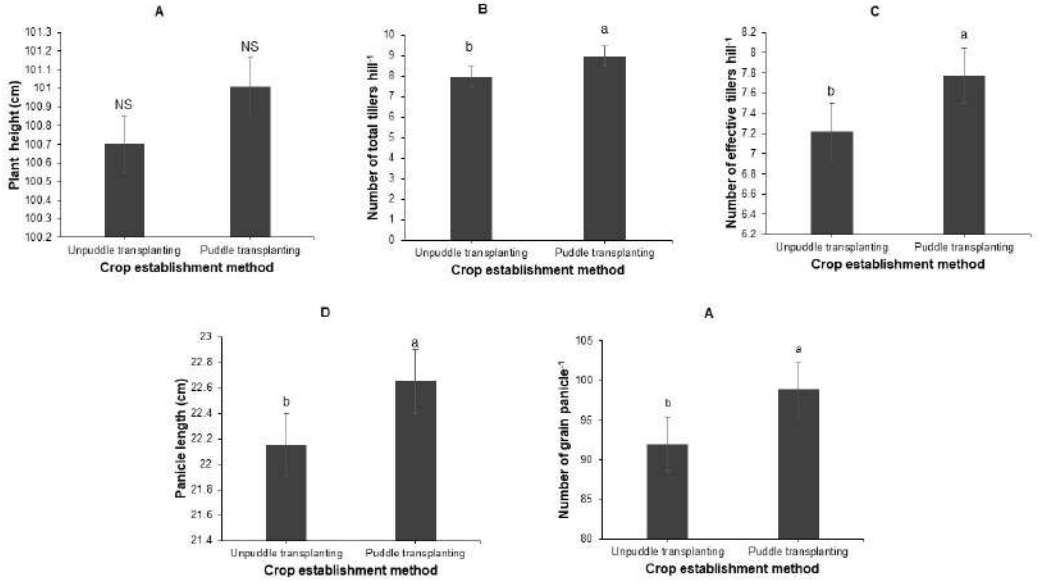

Figure 1. Effect of crop establishment method on growth and yield contributing parameters of T. Aman rice. Figures with different letters exhibit significant variations, means with the same letter do not.

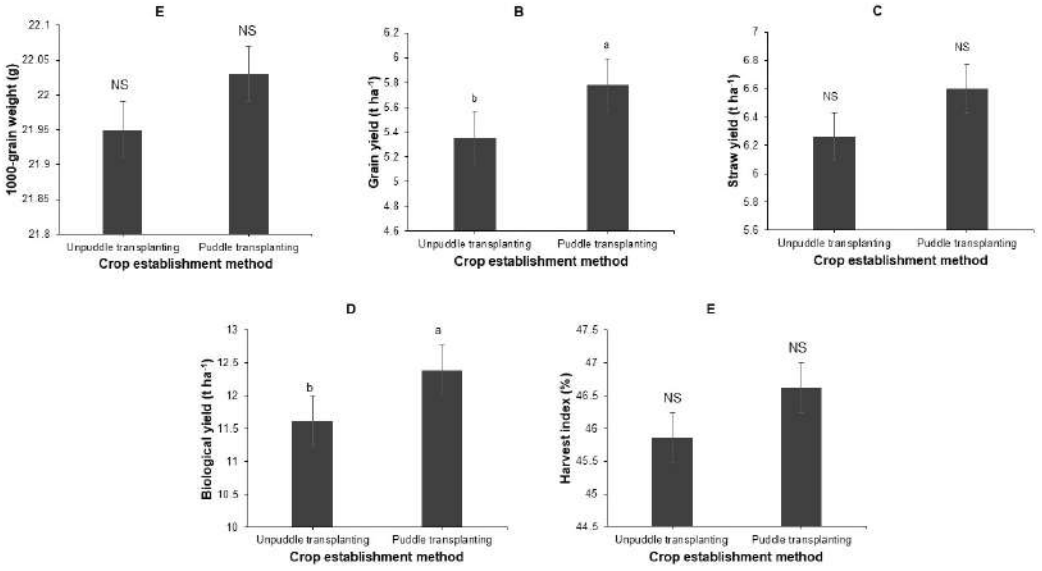

Figure 2. Effect of crop establishment method on yield and yield contributing parameters of T. Aman rice. While figures with different letters exhibit significant variations, means with the same letter do not.

Weight of 1000-grain was significantly affected by different weeding regimes. The heaviest thousand grain weight (22.24 g) was recorded in W_1 (Two hand weedings at 15 and 35 DATs)

treatment, while the lowest (21.82 g) was recorded in W_0 (No weeding) treatment (Figure 4A). This finding corroborates the finding of Ferdus *et al.* (2016) and Islam (2023) who found the highest 1000-grain weight in two weedings treatment. Grain yield was significantly influenced by different weeding regimes. The highest grain yield (6.09 t ha^{-1}) was observed in W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment which was very closely and statistically similar (6.03 t ha^{-1}) to W_1 (Two hand weeding at 15 and 35 DATs) treatment. The lowest grain yield (4.96 t ha^{-1}) was observed in W_0 (No weeding) treatment **(**Figure 4B**).** The increased yield was contributed in W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment by higher number of effective tillers $hill^{-1}$, higher number of grains $pancicle^{-1}$ over no weeding treatment. Similar results were also observed by Afroz *et al.* (2019) and Salam *et al*. (2020a). Straw yield was significantly influenced by different weeding regimes. The highest straw yield (6.91 t ha^{-1}) was observed in W_1 (Two hand weeding at 15 and 35 DATs) treatment, which was nearly and statistically similar with treatments W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT), W_4(Application of pre-emergence herbicide Commit followed by early post-emergence herbicide Paddy plus), and W_6 (Application of early post-emergence herbicide Paddy plus followed by one hand weeding at 35 DAT). On the other hand, the lower straw yield (4.96 t ha^{-1}) was observed in W_0 (No weeding) treatment (Figure 4C). Biological yield had significant effect by different weed management practices. The highest biological yield (12.98 t ha^{-1}) was observed in W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT). The lowest biological yield (8.77 t ha^{-1}) was observed in W_0 (No weeding) treatment (Figure 4D). The highest harvest index (47.12%) was observed in W_3 (Application of early post emergence herbicide Paddy plus (Acetachlor + Bensulfuron methyl) which was nearly and statistically identical to W_5 (Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT), W_4 (Application of pre-emergence herbicide Commit followed by early post-emergence herbicide Paddy plus), W_6 (Application of early post-emergence herbicide Paddy plus followed by one hand weeding at 35 DAT) and W_1 (Two hand weeding at 15 and 35 DATs) treatment. The lowest harvest index (43.04%) was observed in W_0 (No weeding) treatment (Figure 4E).

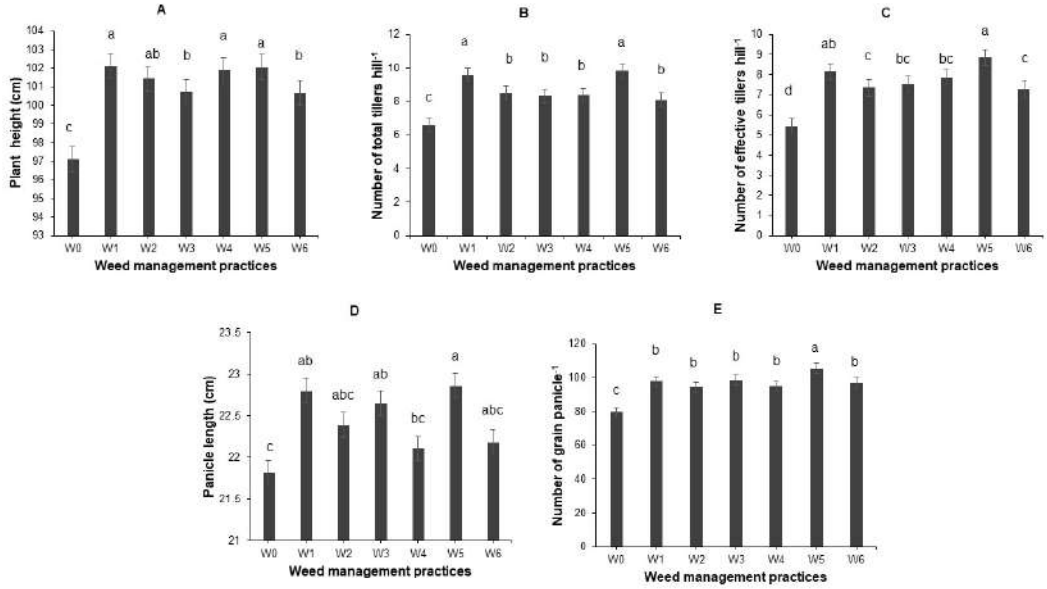

Figure 3: *Effect of weed management practices on growth and yield contributing parameters of T. Aman rice*. Figures with different letters exhibit significant variations, means with the same letter do not. W0 = No weeding, W1=Two hand weeding at 15 and 35 DAT, W2=Application of pre-emergence herbicide Commit (Pretilachlor), W3 = Application of early post emergence herbicide Paddy plus (Acetachlor + Bensulfuron methyl, W4=Application of pre-emergence herbicide Commit followed by early Post-emergence

herbicide Paddy plus, W5 = Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT and W6 = Application of early post-emergence herbicide Paddy plus followed by one hand weeding at 35 DAT.

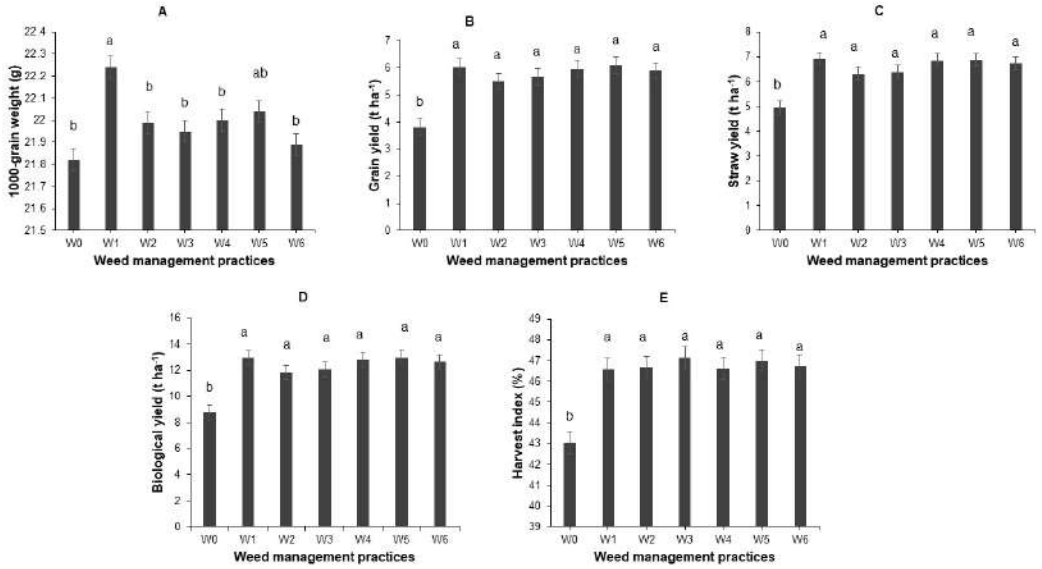

Figure 4. Effect of weed management practices on yield and yield contributing parameters of T. Aman rice. Figures with different letters exhibit significant variations, means with the same letter do not. W0 = No weeding, W1 = Two hand weeding at 15 and 35 DAT, W2= Application of pre-emergence herbicide Commit (Pretilachlor), W3 = Application of early post emergence herbicide Paddy plus (Acetachlor + Bensulfuron methyl, W4 = Application of pre-emergence herbicide Commit followed by early Post-emergence herbicide Paddy plus, W5 = Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT and W6 = Application of early post-emergence herbicide paddy plus followed by one hand weeding at 35 DAT.

Interaction effect of crop establishment method and weed management practices of growth and yield of T. *Aman* rice

The interaction effect of crop establishment method and weed management practices exerted significant effect on plant height. The tallest plant (102.44cm) was obtained from M_2W_1 (Puddle transplanting x Two hand weeding at 15 and 35 DATs) treatment which was nearly similar with M_2W_5 (Puddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT). The shortest plant (96.89cm) was found in M_1W_0 (Unpuddle transplanting method x no weeding) treatment (Table 1). Number of total tillers hill^{-1}was significantly affected by the interaction of crop establishment method and weed management practices. The higher number (10.44) of total tillers hill^{-1} was produced in M_2W_1 (Puddle transplanting method x Two hand weeding at 15 and 35 DATs) treatment which was statistically similar with M_2W_5 (Puddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment and the lowest one (5.99) was produced in interaction of M_1W_0 (Unpuddle transplanting method x no weeding) treatment (Table 1). Significant variation was observed in effective tillers hill^{-1} due to interaction of crop establishment method and weed management practices. The highest number of effective tillers hill^{-1} (9.39) was produced in interaction of M_2W_5 (Puddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment which was statistically similar with M_2W_1 (Puddle transplanting method x Two hand weeding at 15 and 35 DATs) treatment. The lowest number of effective tillers hill^{-1} (5.11) was produced in interaction of M_1W_0 (Unpuddle

transplanting method x no weeding) treatment (Table 1). The longest panicle (23.27cm) was produced in interaction of M_2W_5 (Puddle transplanting x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment and the shortest one (21.59cm) was produced in interaction of M_1W_0 (Unpuddle transplanting method x no weeding) treatment (Table 1).

Table 1: Interaction effect of crop establishment method and weed management practices on crop characters and yield

Interaction (M × W)	Plant height (cm)	Total tillers hill^{-1} (no.)	Effective tillers hill^{-1}(no.)	Panicle length (cm)	Grain panicle^{-1}(no.)	Sterile spikelets panicle^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
M_1W_0	96.89e	5.99f*	5.11e	21.59d	77.96g	12.25	21.81b	3.43b	4.86c	8.29c	41.00b
M_1W_1	101.78abc	8.77bcd	7.66cd	22.36abcd	96.12bcde	12.26	22.13ab	5.94a	6.64a	12.59ab	47.20a
M_1W_2	101.11bcd	7.88de	7.05d	22.16cd	91.48cde	12.75	21.88b	5.47a	6.29a	11.77b	46.60a
M_1W_3	100.66d	7.99cde	7.51cd	22.64abc	96.87bcde	12.29	21.99b	5.53a	6.07ab	11.61b	47.77a
M_1W_4	101.67abcd	8.21bcde	7.89bcd	22.02cd	91.28de	11.45	22.01b	5.73a	6.86a	12.59ab	45.60a
M_1W_5	102.11ab	9.33ab	8.30bc	22.45abcd	101.30ab	12.87	22.00b	5.75a	6.52a	12.28ab	46.91a
M_1W_6	100.66d	7.66de	7.03d	21.86cd	88.88ef	12.19	21.85b	5.59a	6.61a	12.20ab	45.94a
M_2W_0	97.33e	7.18ef	5.75e	22.05cd	81.19fg	12.63	21.83b	4.19b	5.06bc	9.25c	45.07ab
M_2W_1	102.44a	10.44a	8.66ab	23.24ab	99.56bcd	11.95	22.35a	6.11a	7.18a	13.29ab	45.94a
M_2W_2	101.78abc	9.10bc	7.66cd	22.63abc	97.45bcde	12.24	22.09ab	5.54a	6.35a	11.89ab	46.69a
M_2W_3	100.78cd	8.66bcd	7.55cd	22.65abc	100.46bc	12.73	21.92b	5.80a	6.71a	12.52ab	46.47a
M_2W_4	102.11ab	8.55bcd	7.81bcd	22.20bcd	98.44bcd	11.75	21.99b	6.21a	6.84a	13.06ab	47.64a
M_2W_5	102.00ab	10.33a	9.39a	23.27a	109.74a	12.41	22.08ab	6.43a	7.25a	13.68a	47.01a
M_2W_6	100.67cd	8.55bcd	7.57cd	22.50abcd	105.11ab	12.64	21.94b	6.20a	6.84a	13.05ab	47.50a
Level of significance	**	**	**	**	**	NS	**	**	**	**	*
CV (%)	2.67	7.08	7.51	5.85	5.10	12.67	2.85	9.04	4.70	5.31	4.15

In a column, figures with same letter (s) or without letter do not differ significantly whereas figures with dissimilar letter differ significantly (as per DMRT), ** = Significant at 1% level of probability, * = Significant at 5% level of probability, NS= Not significant

M_1=Unpuddle and M_2= Puddle transplanting method , W_0= No weeding, W_1= Two hand weeding at 15 and 35 DATs, W_2=Application of pre-emergence herbicide Commit (Pretilachlor), W_3= Application of post- emergence herbicide Paddyplus (Acetachlor + Bensulfuron methyl), W_4=Application of pre-emergence herbicide Commit (Pretilachlor followed by early post emergence herbicide Paddyplus, W_5=Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DATs and W_6=Application of post- emergence herbicide Paddyplus followed by one hand weeding at 35 DATs.

The highest number of grains panicle^{-1} (109.74) was produced in interaction of M_2W_5 (Puddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment while the lowest number of grains panicle^{-1} (77.96) was found in interaction of M_1W_0 (Unpuddle transplanting method x no weeding) treatment (Table 1). Weight of 1000-grain was significantly affected by different crop establishment methods and weed management practices. The heaviest 1000-grain weight (22.35 g) was produced in the interaction of M_2W_1 (Puddle transplanting method x Two hand weeding at 15 and 35 DATs) treatment and the lowest thousand grain weight (21.81 g) was produced in the interaction of M_1W_0 (Unpuddle transplanting method x no weeding) treatment (Table 1). Grain yield was significantly influenced by different crop establishment methods and weed management practices. The highest grain yield (6.43 t ha^{-1}) was recorded in the interaction of M_2W_5 (Unpuddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment. Treatments M_2W_1 (Puddle transplanting method x Two hand weeding at 15 and 35 DAT) (6.11 t ha^{-1}) was nearly similar and statistically identical. The lowest grain yield (3.43 t ha^{-1}) was produced by M_1W_0 (Unpuddle transplanting method x no weeding) (Table 1). The lower grain yield by Unpuddle transplanting method in no weeding practices might be due to the poor performance of yield contributing characters like number of effective tillers hill^{-1} and number of grains panicle^{-1}. Because of severe weed infestation occurred in the plots due to competition for moisture, nutrients between weed and rice plants. Similar results were also reported by Afroz *et al.* (2019), Mia *et al.* (2023) and Osman *et al.* (2020). The higher straw yield (7.25 t ha^{-1}) was produced in the interaction of M_2W_5 (Puddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment which was statistically identical to M_2W_1 (Puddle transplanting method x Two hand weeding at 15 and 35 DATs). The lower straw yield (4.86 t ha^{-1}) was produced in the interaction of M_1W_0 (Unpuddle transplanting method x no weeding) (Table 1). Similar results were observed by Afroz *et al*. (2019), Rahman *et al.* (2020b) and Salam *et al.* (2020). The highest biological yield (13.68 t ha^{-1}) was recorded in the interaction of M_2W_5 (Puddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT) treatment. The lowest biological yield (8.29 t ha^{-1}) was produced in M_1W_0 (Unpuddle transplanting method x no weeding) treatment (Table 1).The highest harvest index (47.77%) was observed in M_1W_3 (Unpuddle transplanting method x Application of early post emergence herbicide Paddyplus (Acetachlor + Bensulfuron methyl) which was statistically identical to M_2W_5 (Puddle transplanting method x Application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT)) treatment. The lowest harvest index (41%) was observed in M_1W_0 (Unpuddle transplanting method x no weeding) treatment (Table 1).

CONCLUSION

All the parameters on yield and yield contributing characters were significantly influenced by crop establishment methods. The higher grain yield obtained in puddle transplanting method then they're that of other method was due to the higher number of effective tillers hill^{-1}, panicle length and grains panicle^{-1}. Weed management practices had also significant influence on crop growth, yield and yield contributing characters. From the present study it was observed that weeding treatment, pre-emergence herbicide Commit followed by one hand weeding at 35 DAT produced the highest grain yield. Therefore, it may be concluded that puddle transplanting method with application of pre-emergence herbicide Commit followed by one hand weeding at 35 DAT might be used for controlling weed as well as obtaining highest grain yield of BRRI dhan58.

ACKNOWLEDGEMENT

The authors are grateful to Bangladesh Agricultural University Research System (BAURES), Bangladesh Agricultural University for financial support through the research project entitled "Effects of methods of crop establishment on the growth and yield of rice".

REFERENCES

Afrina, R., Salam, M.A. & Kader, M.A. (2019). Effect of crop establishment methods on the yield of *boro* rice. *Journal of the Bangladesh Agricultural University* 17(4), 521-525.DOI: 10.3329/jbau.v17i4.44621

Afroz, R., Salam, M.A. & Begum, M. (2019). Effect of weeding regime on the performance of *boro* rice cultivars: Effect of weeding on *boro* rice. *Journal of the Bangladesh Agricultural University* 17(3), 265-273. https://doi.org/10.3329/jbau.v17i3.43192

Ahmed, G.J.U., Mridha, A.J., Bhuiyan, M.K.A., Riches, C.R. & Mortimer, M. (2003). Effect of different weed management systems on weed control, plant growth and grain yield of lowland rice. *In Proceedings of Nineteenth Asian Pacific Weed Science Society Conference*. pp. 17-21.

Ali, M., Haque Bir, M.S., Rahman, M.H., Ayesha, S.K., Hoque, A., Harun-Ar-Rashid, M. & Park, K.W. (2018). Effect of crop establishment and weed control method on productivity of transplanted *aman* rice. *Weed & Turfgrass Science* 7(2), 120-129.https://doi.org/10.5660/WTS.2018.7.2.120

Ashraf, S., Sarker, U.K., Perveen, S., Shah, M.S.I., Azam, G. & Uddin, M.R. (2021). Weed control efficacy of combined application of grass pea and mustard crop residues in T. *aman* rice. *Archives of Agriculture and Environmental Science* 6(2), 134-141.https://doi.org/10.26832/24566632.2021.060204

BBS (Bangladesh Bureau of Statistics) (2020). Yearbook of Agricultural Statistics-2019. 31st ser., Statistics and Informatics Division (SID), Ministry of Planning, Government of the People's Republic of Bangladesh.

Bell, R. W., Haque, M. E., Johansen, C., Vance, W., Kabir, M. E., Musa, M. A. & Islam, M. A. (2018). Mechanised minimum soil disturbance establishment and yield of diverse crops in paddy fields using a two-wheel tractor-mounted planter suitable for smallholder cropping. *Experimental Agriculture* 54(5), 755-773.https://doi.org/10.1017/S0014479717000370

Bhuyan, M.H.M., Ferdousi, M.R. & Iqbal, M.T. (2012). Yield and Growth Response to Transplanted Aman Rice under Raised Bed over Conventional Cultivation Method. *International Scholarly Research Notices, 2012,* Article ID 646859, 8 pages. https://doi.org/10.5402/2012/646859

BRRI (Bangladesh Rice Research Institute) 2018: Annual Report. Bangladesh Rice Research Institute Joydevpur, Gazipur, Bangladesh.

Fahad, S., Adnan, M., Noor, M., Arif, M., Alam, M., Khan, I.A. & Wang, D. (2019). Major constraints for global rice production. In *Advances in rice research for abiotic stress tolerance* (pp. 1-22). Woodhead Publishing.https://doi.org/10.1016/B978-0-12-814332-2.00001-0

Ferdous, J., Islam, N., Salam, M.A. & Hossain, M.S. (2016). Effect of weed management practices on the performance of transplanted *aman* rice varieties. *Journal of the Bangladesh Agricultural University*, *14*(1), 17-22.DOI:10.3329/JBAU.V14I1.30591

Gathala, M.K., Timsina, J., Islam, M.S., Krupnik, T.J., Bose, T.R., Islam, N., & McDonald, A. (2016). Productivity, profitability, and energetics: A multi-criteria assessment of farmers' tillage and crop establishment options for maize in intensively cultivated environments of South Asia. *Field crops research*, 186 32-46.https://doi.org/10.1016/j.fcr.2015.11.008

Gomez, K.A. & Gomez, A.A. (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. New York, Chichester, Brishbane, Toronto. pp. 207-215.

Islam, A.K.M.S., Hossain, M.M. & Saleque, M.A. (2014). Effect of unpuddled transplanting on the growth and yield of dry season rice (*Oryza sativa* L.) in high barind tract. *The Agriculturists* 12(2), 91-97.

Islam, M.S. (2023). Assessment of combined effect of *Eleocharis atropurpurea* and *Fimbristylis dichotoma* residues on the yield performance of T. *aman* rice. *Journal of Agriculture, Food and Environment (JAFE)| ISSN (Online Version):* 2708-5694, 4(1).https://doi.org/10.47440/JAFE.2023.4103

Islam, M.S., Sarker, A.K., Mia, M.L., Talukder, S.K., Neshe, F.A., Sarkar, M. & Zaman, F. (2023) Effect of seedlings per hill and harvesting time on the yield performance of purple rice. *European Academic Research*, 11(5), 637-647.

Kalita, J., Ahmed, P. & Baruah, N. (2020). Puddling and its effect on soil physical properties and growth of rice and post rice crops: A review. *Journal of Pharmacognosy and Phytochemistry* 9(4), 503-510.

Khan, M.A.H., Sultana, N., Akter, N., Akhter, S. & Khan, M.A.I. (2020). Development of potato-boro-T. *aman* rice cropping pattern against fallow-boro-T. *aman* rice cropping pattern at Mymensingh. *Bangladesh Journal of Agricultural Research* 45(3), 279-292.

Li, Y.X., Tullberg, J.N. & Freebairn, D.M. (2007). Wheel traffic and tillage effects on runoff and crop yield. *Soil and Tillage Research* 97(2), 282-292.https://doi.org/10.1016/j.still.2005.10.001

Mia, M., Begum, M., Riza, I., Kabir, M., Neshe, F., Monira, S. & Islam, M. (2023). Green Global Foundation©. *International Journal of Sustainable Crop Production* 18(1), 10-18.

Nagarjuna, P., Venkateswarlu, B., Sreerekha, M., Prasad, P.R.K. & Jayalalitha, K. (2021). Effect of crop establishment methods and nitrogen management on growth and yield of rice. http://10.30954/0974-1712.02.2021.10

Osman, M.A., Hossen, K., Chowdhury, R.H., Tabassum, C.N., Khairul, M., Islam, R.A. & Ferdous, T. (2020). Assessment of different weed control methods on growth and yield performance of T. *aus* rice. *Agricultural Research & Technology: Open Access Journal* 24(3), 87-92.DOI: 10.19080/ARTOAJ.2020.24.556267

Rahman, A., Salam, M.A., Kader, M.A., Islam, M.S. & Perveen, S. (2020a). Growth and yield of boro rice (*Oryza sativa* L.) in response to crop establishment methods and varieties. *Archives of agriculture and environmental science*, 5(2), 137-143.https://doi.org/10.26832/24566632.2020.050208

Rahman, M.M. (2014). Effect of weeding regime on the performance of the transplanted *Aman* rice. PhD dissertation, Department of Agronomy, Bangladesh Agricultural University, Mymnesingh-2202, Bangladesh.

Rahman, M.M. (2016). Sustainable weed management for unpuddled transplanted rice. *Advances in Plants Agricultural,* 5(2), 501–502.

Rahman, S.H., Uddin, M.R., Salam, M.A., Sarker, U.K., Rasul, S. & Hasan, M. (2020b). Weed management and crop performance of rice as influenced by different crop residues. *Archives of Agriculture and Environmental Science,* 5(3), 275-282.https://doi.org/10.26832/24566632.2020.050307

Salam, M.A. (2020). Effect of weed management on the growth and yield performances of boro rice cultivars. *Journal of Agriculture, Food and Environment (JAFE)| ISSN (Online Version):* 2708-5694, 1(4), 19-26.https://doi.org/10.47440/JAFE.2020.1404

Sayeed, K.A. & Yunus, M.M. (2018). Rice prices and growth, and poverty reduction in Bangladesh. FAO: Rome, Italy. p. 45.

Sharma, S.N. (2008). Soil Fertility and Nutrient Management. Division of Agronomy, *Indian Agricultural Research Institute*, New Delhi – 110 012, India. pp. 1-59.

Singh, A., Kumar, R., & Kang, J.S. (2014). Tillage system, crop residues and nitrogen to improve the productivity of direct seeded rice and transplanted rice. *Current Agriculture Research Journal,* 2(1), 14-29.http://dx.doi.org/10.12944/CARJ.2.1.03