Performance of Boro rice cv. BRRI dhan28 as Influenced by Different Plant Establishment Methods and Weeding Regimes

Md Sojib Kabiraj¹, Md Mamunur Rashid², Md Parvez Anwar¹, Md Delwar Hossain¹
¹Department of Agronomy, Bangladesh Agricultural University, Mymensingh, Bangladesh
²Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Mymensingh, Bangladesh

Abstract:
At present time food safety is a precedence issues in Bangladesh. It is essential to increase the production level of rice to address this mission. Suitable plant establishment method is necessary to get higher yield. Indifferent of the method of establishment, weeds are a prime barrier to rice production. Enormity of weed infestation, types of weed species and types of associated crop causes yield loss of rice. The study was undertaken to evaluate the yield performance of Boro rice cv. BRRI dhan28 under different plant establishment methods and weeding regimes. The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during December 2017 to June 2018. It was a two factor experiment that comprehended three plant establishment methods viz. sprouted seeds in line, sprouted seeds in broadcasting and transplanting of seedlings in line; five weeding regimes viz. no weeding, one hand weeding at 20 Day After Planting (DAP), two hand weeding at 20 and 40 DAP, three hand weeding at 20, 40 and 60 DAP, and application of herbicide. The experiment was observed in a randomized complete block design with three replications. Yield contributing characters and yield of Boro rice were exerted significantly by plant establishment methods and the highest results were recorded in transplanting of seedlings in line method in which the number of total tiller hill⁻¹ (6.39), number of effective tiller hill⁻¹ (5.93), grains panicle⁻¹ (99.28), 1000 grain weight (24.16 g) and grain yield (4.19 t ha⁻¹). And the lowest results were found in sprouted seeds in broadcasting method. Considering weeding regimes, the highest number of total tillers hill⁻¹ (6.03), effective tillers hill⁻¹ (5.28), grains panicle⁻¹ (101.4), grain yield (4.12 t ha⁻¹) and straw yield (5.74 t ha⁻¹) were recorded with application of herbicide method. Contrariwise, no weeding showed the lowest values. In interaction effect, maximum grain yield (4.48 t ha⁻¹) was obtained in transplanting of seedlings in line method with application of herbicide and Sprouted seeds in broadcasting method with no weeding was performed the lowest grain yield (2.86 t ha⁻¹). In the overall results the growers can be recommended to cultivate Boro rice cv. BRRI dhan28 in transplanting of seedlings in line method with application of herbicide at different Agro-ecological zones of Bangladesh.

Key word: Boro rice; Plant establishment method; Weeding regime; Yield; BRRI dhan28

Date of Submission: 02-08-2020 Date of Acceptance: 17-08-2020

I. Introduction

Rice (Oryza sativa L.) is the most important semi-aquatic annual grass plants under Gramineae family. About 135 million people of Bangladesh consume rice as their staple food. Bangladesh as an agro-based developing country is striving hard for its rapid development of economy. The economic development of this country is mainly depended on agriculture. The contribution of this sector in GDP is 14.32% (BBS, 2017). This sector plays significant impact on poverty alleviation, human resource development and food security. In Bangladesh, rice is main food crop and about 84.67% of cropped area is used for rice production with annual production of 34.42 million tons (BBS, 2017). However, the area and production of Boro rice in the country were 4.14 million hectares and 15.89 million tons gradually in 2016-2017 (BBS, 2017). For the last few years, the production in agricultural sector was startling and the most momentous role was played by rice. So, it is necessary to accept further steps to increase the production level of rice.

Transplanting is the most common and elaborative plant establishment technique in irrigated situation across Bangladesh. But in dry condition and deep water culture direct-seeded practice is widely used (Alim, 1982). Pre-germinated seedlings are used to transfer the wet field from seedbed. It requires less seed and enables the crop to be planted right time in the field as nurseries raised in advanced. It is an effective method to control weeds and other intercultural operations. The seedlings are shown at the time of transplanting are able to
Performance of Boro rice cv. BRRI dhan28 as Influenced by Different Plant Establishment Methods and Weeding Regimes.

Compete with weeds that propagated. That’s why weed infestation is generally much lower in transplanted rice compared to direct-seeded rice which increase crop yield. Mechanical power or manual labor is used to transplant rice seedling in the main field. It is troublesome and cost intensive practice because considerable amount of labor that is required to transplant (Islam et al., 2016). However, compared to direct-seeded rice the growth duration of transplanted rice is somewhat longer because of the stress procured by transplantation. In Boro season, a large amount of seedlings are damaged due to dense fog and cold weather and the availability of seedlings become shortage. Farmers are now switching over to direct seeding method under puddle conditions as wet seedling reduces the amount of labor needed for growing rice crop. Wet seeding also helps to harvest earlier by 8-10 days than transplanted rice. It can eliminate the operations such as nursery bed preparation, care of seedling, pulling, transporting and transplanting to the main field (Chandrapala, 2009 and Sreeleatha, 2011). However, in direct-seeded rice crop weed infestation becomes higher which reduce yield. So, to get maximum yield by avoiding weed infestation appropriate plant establishment method should be selected.

In rice cultivation weed creates serious yield reduction problems. Weed infestation is an innate phenomenon in rice field. Improperly controlled weeds compete for soil nutrition with more rapidly in growth and cause reduction of yield and grain quality. A large number of noxious weed species are grown in rice field as the climatic condition of Bangladesh is favorable for weeds. Weed acts as a barrier for rice plants that compete for nutrients, space, water, air and light (Miah et al., 1990). Each kilogram weed infestation reduce approximately 0.75 kg yield in rice crop. In rice production weeds are major biotic constraints (Yeasmin and Ye 2008) and weed management is a serious challenge for farmers and researcher as well (Awner et al., 2011). Weed management requires a large number of labor which increase the production cost. From the economic point of view lower cost of weeding is preferable. Choosing the suitable weeding regime depends on weed flora, weed dynamics, weed intensity, time of weeding and soil moisture. The cost of production of rice can be reduced by adopting of alternative methods of weed control which includes mechanical, biological and chemical weed control in combination with manual weeding. Herbicides and mechanical weeding are the alternative to hand weeding. However, herbicides are getting popularity at present time because it saves labor and regarded as cost effective. In controlling weeds numerous pre-emergence herbicides are used together with hand weeding (Ahmed et al., 2003). So, the selection of the effective weeding regime plays an important role to get higher yield by reducing the weed infestation.

Choosing a suitable plant establishment method and weed management practice is imperative for rice production in a sustainable way. Hence, the present study was undertaken to find out the yield performance of Boro rice cv. BRRI dhan28 under different plant establishment methods and weeding regimes.

**II. Materials and Methods**

The experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period in December 2017 to June 2018. The experiment consisted three plant establishment method viz Sprouted seeds in line, Sprouted seeds in broadcast, Transplanting of seedlings in line; five weeding regimes viz: no weeding, one hand weeding at 20 DAP, two hand weeding at 20 DAP, three hand weeding at 20, 40 and 60 DAP, and application of herbicide (Sathi 10WP @ 185 g ha⁻¹). The experiment was placed in a randomized complete block design (RCBD) with three replications. Thus total numbers of unit plot was 45. The space between blocks and between unit plots was 1.0 m and 0.75 m. The size of the unit plot was 10m² (4.0 x 2.5 m). Seeds of BRRI dhan28 were collected in the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh. After soaking in water for 48 hours the sprouted seeds were sown in 30 plots for direct seeding, 15 plots of them were placed with sprouted seeds in line and 15 plots of them were sprouted seeds in broadcast. Sprouted seeds were sown in 25 cm individual lines successively and for the broadcast, sprouted seeds were randomly broadcasted on 12 December 2017. For transplanting of seedlings in line method, seedlings were raised on nursery bed. Sprouted seeds were broadcasted on prepared nursery bed on 12 December 2017. Fourteen five days old seedlings were then transplanted on 27 January 2018 with 25 cm x 15 cm spacing at two seedlings per hill⁻¹. Weeding was done as per experimental treatments. In case of no weeding treatment, weeds were allowed to grow in the plots in sowing to harvesting of the crop. Others intercultural operations were done for ensuring and maintaining the normal growth of the crop. Harvesting was done when 90% of grains turned yellow. The plants in one square meter area in the centre of the plot were harvested at ground level. The direct seeded plots were mature earlier than the transplanted plots. The direct seeded mature plots were harvested on 25 May, 2018. And the transplanted plots were harvest on 5 June, 2018. The crop was then separately threshed, grain and straws were sun dried thoroughly and weights were recorded. Prior to the harvest, five hills were randomly selected in each unit plot to collect data on yield components. While it was completed to collect the data then the grains and straws in five sampling hill were added to the total grain and straw yield. All the recorded data were compiled
and tabulated for statistical analysis. The mean differences of the treatments were analyzed by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

III. Results and Discussion

Effect of plant establishment method:

Plant establishment methods affected significantly to yield contributing characters and yield of Boro rice cv. BRRI dhan28 (Table 1). Tallest plant (85.26 cm) was obtained in transplanting of seedling in line method and shortest plant (76.62 cm) was recorded in sprouted seeds in broadcasting method. Maximum spacing and more availability of nutrients ensure highest growth in transplanted rice crop. Chandrapala (2009) and Mahapatra et al. (1985) found the similar results. The highest number of total tiller hill\(^{-1}\) (6.39) was obtained in transplanting of seedlings in line method and the lowest tiller hill\(^{-1}\) (4.58) was found in sprouted seeds in broadcasting method. Biswas and Salokhe (2005) reported similar results. The highest number of effective tillers hill\(^{-1}\) (5.93) was found in transplanting of seedlings in line method and lowest number of effective tillers hill\(^{-1}\) (3.74) was found with sprouted seeds in broadcasting method. It may be the fact that transplanting method provides enough nutrients, lights and air which helped in producing maximum effective tillers hill\(^{-1}\). The findings of Mridha et al. (1991) were same. Highest number of non-effective tillers hill\(^{-1}\) (0.85) was found in sprouted seeds in broadcasting method and lowest number of non-effective tillers hill\(^{-1}\) (0.46) was found in transplanting of seedlings in line method. Akbar (2004) found the highest number of non-effective tillers hill\(^{-1}\) in direct seeded method in rice. Numerically the longest panicle (21.62 cm) was obtained in transplanting of seedlings in line method and shortest panicle (21.20 cm) was obtained in sprouted seeds in broadcasting method. Goel and Verma (2000) found longest panicle length in the transplanting. Transplanting of seedling in line method showed highest number of grains panicle\(^{-1}\) (99.28) and lowest grains panicle\(^{-1}\) (96.97) was in sprouted seeds in broadcasting method. Reddy and Ghosh (1987) were the same observations who stated that transplanting method produced highest number of grains panicle\(^{-1}\). Transplanting of seedling in line method showed lowest number of sterile spikelet panicle\(^{-1}\) (11.65) and the highest (11.78) was in sprouted seeds in broadcasting method. Ang et al. (2002) reported similar result. The highest weight of 1000 grain (24.16 g) was observed in transplanting of seedlings in line method and the lowest weight of 1000-grain (23.23 g) was observed in sprouted seeds in broadcast method. Xiang et al. (1999) found higher 1000-grains weight in transplanting seedlings than sprouted seeds. It was found that the highest grain yield (4.19 t ha\(^{-1}\)) and straw yield (6.19 t ha\(^{-1}\)) were obtained in transplanting of seedling in line method and the lowest grain yield (3.33 t ha\(^{-1}\)) and straw yield (4.15 t ha\(^{-1}\)) were obtained in sprouted seeds in broadcasting method. Roy et al. (1990) and Chowdhury (1993) reported same observations and stated that yield depends on some contributing characters. Highest harvest index (44.51 %) was produced by sprouted seeds in broadcasting method and lowest harvest index (40.36 %) was found in transplanting of seedlings in line method. Sarkar et al. (2003) reported highest harvest index in direct seeded crops than the nursery seedlings.

Effect of weeding:

Yield components and yield of Boro rice cv. BRRI dhan28 were significantly affected by weeding regimes (Table 2). The tallest plant (81.77 cm) was obtained in application of herbicide and the shortest plant height (79.33 cm) was obtained in no weeding. The highest number of total tillers hill\(^{-1}\) (6.03) was obtained in application of herbicide and no weeding showed the lowest number of total tillers hill\(^{-1}\) (4.38). Competition between rice plants and weeds for nutrients and water was lowest in case of application of herbicide compared to no weeding. It may be the fact that favored rice plants to produce more tillers reported by Walia et al. (2009). The highest number of effective tillers hill\(^{-1}\) (5.28) was obtained in application of herbicide and the lowest number of effective tillers hill\(^{-1}\) (3.83) was recorded in no weeding. Lowest competition between rice plants and weeds in case of herbicide application might have resulted in highest number of effective tillers hill\(^{-1}\). Smith (1981) was supported this results. The highest number of non-effective tillers hill\(^{-1}\) (0.76) was obtained in no weeding and the lowest number of non-effective tillers hill\(^{-1}\) (0.55) was obtained in application of herbicide. Similar observations were also made by Singh and Ghosh (2007). Lowest number of non-effective tillers hill\(^{-1}\) found where there were highest weed competition. The longest panicle (21.80 cm) was obtained in application of herbicide. The shortest panicle (21.14 cm) was obtained in no weeding. These results are in conformity with the findings of Sharma et al., (1994). The highest number of grains panicle\(^{-1}\) (101.4) was recorded in application of herbicide and the lowest number of grains panicle\(^{-1}\) (90.84) was showed by no weeding. Less competition among rice plants and weeds might have encouraged the distribution of assimilates towards grains resulting in highest number of grains panicle\(^{-1}\). This observation was similar to Mukhopadhyay and Ghosh (1981). The highest number of sterile spikelets panicle\(^{-1}\) (13.45) was obtained in no weeding and the lowest number of sterile spikelets panicle\(^{-1}\) (11.15) was obtained in application of herbicide. The highest number of fertile spikelets in no weeding might be due to severe competition between weeds and rice plants. Sreeelatha (2011) reported that less weed competition resulted in lower sterility in rice. The highest weight of 1000-grain (23.69 g) was obtained in...
application of herbicide and the lowest weight of 1000-grain (23.51g) was obtained in no weeding. The results are in conformity with the findings of Rekha et al. (2002) and Shan et al. (2012). The highest grain yield (4.12 t ha\(^{-1}\)) and straw yield (5.76 t ha\(^{-1}\)) were found in application of herbicide method. On the contrary the lowest grain yield (3.42 t ha\(^{-1}\)) and straw yield (4.51 t ha\(^{-1}\)) were obtained in no weeding. Grain yield increases due to the contribution of number of effective tillers, number of spikelet’s panicle\(^{-1}\) and individual grain weight. And Straw yield decreased with the increase in weed infestation. Bhat et al. (2011) reported similar results. The highest harvest index (43.12%) was obtained in no weeding and the lowest harvest index (42.06%) was found in application of herbicide.

### Table 1. Effect of plant establishment method on yield contributing characters and yield of Boro rice (cv. BRRI dhan28)

| Plant establishment method | Plant height (cm) | Number of total tiller hill\(^{-1}\) | Number of effective tiller hill\(^{-1}\) | Panicle length (cm) | Number of grains panicle\(^{-1}\) | Number of sterile spikelet panicle\(^{-1}\) | 1000 grain weight (g) | Grain yield (t ha\(^{-1}\)) | Straw yield (t ha\(^{-1}\)) | Biological yield (t ha\(^{-1}\)) | Harvest index (%) |
|----------------------------|------------------|-------------------------------------|----------------------------------------|---------------------|----------------------------------|------------------------------------------|------------------------|--------------------------|-----------------------------|-------------------------------|------------------|
| M\(_1\)                    | 80.08 b          | 5.20b                               | 4.48b                                  | 0.73b               | 21.20                            | 98.03                                    | 11.66                  | 23.51 b                  | 3.95 b                      | 5.31 b                        | 9.26b             |
| M\(_2\)                    | 76.62 c          | 4.58c                               | 3.74c                                  | 0.85a               | 21.58                            | 96.97                                    | 11.78                  | 23.23 c                  | 3.33 c                      | 4.15 c                        | 7.48c             |
| M\(_3\)                    | 85.26 a          | 6.39a                               | 5.93a                                  | 0.46c               | 21.62                            | 99.28                                    | 11.65                  | 24.16 a                  | 4.19 a                      | 6.19 a                        | 10.38a            |

LSD\(_{(0.05)}\) 1.81
SX Level of Significance
** NS NS NS NS NS NS NS NS NS NS NS NS NS
CV (%) 3.01 7.41 7.18 42.34 2.36 4.97 11.15 1.47 4.49 3.32 3.14 2.55

In a column, figures having dissimilar letter (s) differ significantly as per DMRT

**=Significant at 1% level of probability,
NS=Not significant
LSD= Least Significant Difference

Where,
M\(_1\)= Sprouted seeds in line, M\(_2\)= Sprouted seeds in broadcasting, M\(_3\)= Transplanting of seedlings in line

### Table 2. Effect of weeding regimes on yield contributing characters and yield of Boro rice (cv. BRRI dhan28)

| Weeding Regimes | Plant height (cm) | Number of total tiller hill\(^{-1}\) | Number of effective tiller hill\(^{-1}\) | Panicle length (cm) | Number of grains panicle\(^{-1}\) | Number of sterile spikelet panicle\(^{-1}\) | 1000 grain weight (g) | Grain yield (t ha\(^{-1}\)) | Straw yield (t ha\(^{-1}\)) | Biological yield (t ha\(^{-1}\)) | Harvest index (%) |
|-----------------|------------------|-------------------------------------|----------------------------------------|---------------------|----------------------------------|------------------------------------------|------------------------|--------------------------|-----------------------------|-------------------------------|------------------|
| W\(_0\)          | 79.33            | 4.38c                               | 3.83c                                  | 0.76                | 21.14ab                         | 90.84ab                                  | 13.45a                 | 23.51                    | 3.42c                       | 4.51d                        | 7.93d             |
| W\(_1\)          | 79.96            | 5.27b                               | 4.65b                                  | 0.73                | 21.27b                          | 98.85a                                  | 10.92b                 | 23.63                    | 3.69b                       | 4.99c                        | 8.68c             |
| W\(_2\)          | 80.99            | 5.45b                               | 4.75b                                  | 0.70                | 21.40b                          | 99.64a                                  | 11.58b                 | 23.66                    | 3.82b                       | 5.18b                        | 9.00b             |
| W\(_3\)          | 81.23            | 5.85a                               | 5.09a                                  | 0.61                | 21.39a                          | 99.76a                                  | 11.39b                 | 23.68                    | 4.06a                       | 5.66a                        | 9.72a             |
| W\(_4\)          | 81.77            | 6.03a                               | 5.28a                                  | 0.55                | 21.80ab                         | 101.4a                                  | 11.15b                 | 23.69                    | 4.12a                       | 5.74a                        | 9.86a             |
The interaction effect of plant establishment method and weeding regimes:

The interaction effect of plant establishment method and weeding exposed significant influence on yield components and yield of Boro rice cv. BRRI dhan28 (Table 3). Transplanting of seedling in line method with application of herbicide produced the tallest plant (87.20 cm) and the shortest plant (72.33 cm) was obtained in weeded plants in broadcasting method with no weeding. Lowest crop–weed competition ensures favorable environment for crop growth. The results are in accordance with the findings of Ahmed et al. (2012). The highest number of total tillers hill$^{-1}$ (7.70) was obtained in transplanting of seedling in line method with application of herbicide. Elsewhere the lowest number of total tillers hill$^{-1}$ (3.70) was found in sprouted seeds in broadcasting method with no weeding. Similar observation was reported by Subramanian et al. (2006). The highest number of effective tillers hill$^{-1}$ (7.70) was listed in transplanting of seedling in line method with application of herbicide. Besides the lowest number of effective tillers hill$^{-1}$ (3.27) was found in sprouted seeds in broadcasting method with no weeding. Hugar et al. (2009) and Sinha and Talati (2006) also opined similarly. It was found that the highest non-effective tillers hill$^{-1}$ (1.13) was obtained in sprouted seeds in broadcasting method with no weeding and the lowest number of non-effective tillers hill$^{-1}$ (0.26) was obtained in transplanting of seedling in line method with application of herbicide. The longest panicle (22.31 cm) was obtained in transplanting of seedlings in line method with application of herbicide. The shortest panicle (20.74 cm) was obtained in sprouted seeds in line method with no weeding. Paul (1999) found the longest panicle in transplanting of seedlings with weed management practice compared to the clonally propagated tillers. It was observed that numerically the highest number of grains panicle$^{-1}$ (105.5) was computed in transplanting of seedlings in line method with application of herbicide and sprouted of seeds in line method with no weeding showed the lowest number of grains panicle$^{-1}$ (94.15). Dwivedi et al. (1996) found highest total grains panicle$^3$ in transplanting of seedling in weed controlled condition. Xiang et al. (1999) found the similar result. The highest number of sterile spikelet panicle$^{-1}$ (13.73) was obtained in sprouted seeds in line method with no weeding and the lowest number of sterile spikelet panicle$^{-1}$ (10.03) was obtained in transplanting of seedlings in line method with application of herbicide. Nagalakshmi 2002 recorded lowest sterile spikelet in transplanted seedlings in weed maintained condition. The highest weight of 1000-grain was observed (24.54 g) in transplanting of seedlings in line method with application of herbicide and the lowest 1000-grain weight (22.66 g) was obtained in sprouted of seeds in broadcasting method with no weeding. Rahman (1992) found highest 1000-grains weight in the combination of transplanting of seedling and controlled weed practice. The highest grain yield (4.48 t ha$^{-1}$) and straw yield (6.84 t ha$^{-1}$) were counted in transplanting of seedlings in line method with application of herbicide. As opposed to the lowest grain yield (2.86 t ha$^{-1}$) was counted in sprouted seeds in line method with no weeding. Ang et al. (2002) reported that the grain yield of the line transplanting of seedling in rice with weed increased compared to others conventional methods. Chandrapala (2009) also reported similar results. The highest harvest index (47.20 %) was obtained in sprouted of seeds in line with application of herbicide and the lowest harvest index (39.34 %) was obtained in transplanting of seedlings in line method with three hand weeding. Sreenivas (1992) also reported similar observations.
transplanting of seedlings in line method with application of herbicide may be recommended to get higher yield.

IV. Conclusions

Results of the experiment concluded that the best performance was showed in transplanting of seedlings in line method with application of herbicide among the others for cultivation of Boro rice cv. BRRI dhan28. It was recorded the highest grain yield. Therefore, our results suggest that BRRI dhan28 in transplanting of seedlings in line method with application of herbicide may be recommended to get higher yield.

References

[1]. Ahmed S, Mamun AA, Islam MN and Hossain SMA 2003: Critical period of weed competition in transplant Aus rice. Bangladesh Journal of Agriculture 11(2) 1-9.
[2]. Akbar M.K 2004. Response of hybrid and inbred rice varieties to different seedlings ages under system of rice intensification in transplant aman season. M.S.(Ag.) Thesis. Dept. Agron., BAU, Mymensingh.
[3]. Alim A 1982: Bangladesh Rice 18 Garden Road, Dhaka 15.Bangladesh (1st edition) pp 96-99.
[4]. Ang S, Wang X, Xiong Z and Xie S 2002: Assessment of using SRI with the super hybrid rice variety Liangyoupei 9. International Assessments of the System of Rice Intensification. Proc International Conference, Sanya, China Apr (1-4) 112-113.
[5]. Ahmed S, Mamun AA, Islam MN and Hossain SMA 2003: Critical period of weed competition in transplant Aus rice. Bangladesh Journal of Agriculture 11(2) 1-9.
[6]. Akbar M.K 2004. Response of hybrid and inbred rice varieties to different seedlings ages under system of rice intensification in transplant aman season. M.S.(Ag.) Thesis. Dept. Agron., BAU, Mymensingh.

DOI: 10.9790/2380-1308015662 www.iosrjournals.org 61 | Page
Performance of Boro rice cv. BRRI dhan28 as Influenced by Different Plant Establishment..

[7]. Ahmed S, Mamun AA, Islam MN and Hossain SMA 2003: Critical period of weed competition in transplant Aus rice. Bangladesh Journal of Agriculture 11(2) 1-9.

[8]. Akbar M.K 2004. Response of hybrid and inbred rice varieties to different seedlings ages under system of rice intensification in transplant aman season. M.S.(Ag.) Thesis. Dept. Agron., BAU, Mymensin.

[9]. Alam A 1982. Bangladesh Rice 15 Garden Road, Dhaka 15. Bangladesh 1st edition) pp 96-99.

[10]. Ang S, Wang X, Xiong Z and Xie S 2002: Assessment of using SRI with the super hybrid rice variety Liangyoupei 9. International Assessments of the System of Rice Intensification. Proc International Conference, Sanya, China Apr (1-4) 112-113.

[11]. Anwar SM S, Mamun AA, Nasim M, and Babur HM 2011: Grain yield and yield attributes of boro rice as affected by cultivar and weed regime in haor area. Pakistan Journal of Science and Research 41(4) 208-211.

[12]. BBS (Bangladesh Bureau of Statistics) 2017: Monthly Statistical Bulletin of Bangladesh. Bangladesh Bureau of Statistics, Statistic Division, Government of People’s Republic of Bangladesh, Dhaka p 71.

[13]. Bhat MA, Hussain A, Ganai MA and Mushki GM 2011: Effect of herbicides use alone and in combination on weeds and transplant rice under temperate conditions of Kashmir. Applied Biological Research 13(3) 75-78.

[14]. Biswas PK and Solokehe VM 2005: Effects of planting date, intensity of tiller separation and plant density on the yield of transplanted rice. Journal of Agriculture Science 137(3) 279-287.

[15]. Chandrapala AG 2009: Productivity of rice-maze cropping system as influenced by crop establishment methods and nutrient management (S and Zn). PhD thesis submitted to Acharya NG. Ranga Agricultural University pp 176-181.

[16]. Chowdhury SA, Majib MA, Haque KS, Islam M and Rahman MM 1993: Effect of variety on yield and nutritive value of rice straw. Asian Australian Journal of Animal Science 8(4) 329-335.

[17]. Dwivedi DK, Kumar MA, Singh KN and Kumar A 1996: Efficacy of different rice planting methods under mid-upland ecosystem. Journal of Applied Biology 6(1-2) 128-130.

[18]. Gomez KA and Gomez AA 1984: Statistical procedure for agricultural research. Second Edition. International Rice Research Institute, John Wiley and Sons. New York pp 1-340.

[19]. Goel AC and Verma KS 2000: Comparative study of direct seeding and transplanting of rice. Indian Journal of Agriculture Research 34(3) 194-196.

[20]. Hugar AY, Chandrappa H, Jayadeva HM, SatishColor and Mallikarjun GB 2009: Influence of different establishment methods on yield and economics of rice. Agriculture Science Digest 29 (3) 202-205.

[21]. Islam AKM, Islam MT, Rahman MS, Rahman MA and Kim Y 2016: Investigation on selective mechinization for wet season rice cultivation in Bangladesh. Journal of Biosystems Engineering. 41(4) 294-303.

[22]. Mahapatra IC, Singh KN, Pillai KG and Bapat SR 1985: Rice soils and their management. Indian Journal of Agronomy 30 (1).

[23]. Mish MNL, Karim MA, Rahman MS and Islam MS 1999: Performance of Nuzersail mutants under different row spacings. Bangladesh Journal of Training and Development 3 31-34.

[24]. Mirida MA, Nasiruddin JM and Siddique SB 1991: Tiller separation on yield and area covered in rice. Proc of the 16th the Annual BAAS conference held on 5-7 July 1991, Dhaka p 67.

[25]. Mukhopadhyay and Ghosh 1981: Integrated weed management in zero- till directseeded rice (Oryza sativa)–wheat (Triticum aestivum) cropping system. Indian Journal of Agriculture 52 (2) 198-203.

[26]. Nagalakshmi 2002: Drum seeding of sprouted rice seed in a farmer’s field: an economic analysis. International Rice Research Notes 27(1) 54-55.

[27]. Paul SK 1999: Effect of row management and tiller separation on the growth and yield of transplant aman rice. MS Thesis, Department of Agronomy, BAU, Mymensingh pp 76-89.

[28]. Rahman MA 1992: Critical period of weed competition in transplanted Boro rice. Bangladesh Journal of Science and Research 17(2) 151-156.

[29]. Reddy MD and Ghosh BC 1987: Comparative efficiency of different planting methods in intermediate deep water (15-20 cm) rice. Journal of Agricultural Science Cambridge 108 573-577.

[30]. Rekha KB, Raju MS and Reddy MD 2002: Effect of herbicides in transplanted rice. Indian Journal of Weed Science 34 (1&2) 123-125.

[31]. Roy BR, Raju MS and Reddy MD 1990: Weed control in rice – a review. Indian Journal of Weed Science 5(1 & 2) 60-76.

[32]. Sarkar RK, Sanjukta D and Das S 2003: Yield of rainfed lowland rice with medium water depth under anaerobic direct seeding and transplanting. Tropical Science 43(4) 192-198.

[33]. Shan, Sharma GD and Sharma HL 2012: Utilization of weed plants as organic manures under different methods of rice establishment. Indian Journal of Agricultural Sciences 64 (3) 184-186.

[34]. Sinha and Talati 2006: Effect of crop establishment methods, weed management and split nitrogen application on weeds and yield of rice (Oryza sativa). Indian Journal of Agricultural Sciences 75 (5) 285-287.

[35]. Smith RJ 1981: Weeds of major economic importance in rice and yield losses due to weed competition. In: Proceeding of the conference on weed control in rice. International Rice Research Institute, Los Banos, Laguna, Philippines pp 19-36.

[36]. Singh K and Ghosh 2007: Effect of nitrogen and weed control practices on performance of irrigated direct-seeded rice (Oryza sativa). Indian Journal of Agronomy 52 (3) 231-234.

[37]. Sreeleatha 2011: Weed management in different rice cultures and their effects on wheat grown in rice-wheat sequence. Indian Journal of Weed Science 28 (1&2) 30-35.

[38]. Sharma GD and Sharma HL 1994: Utilization of weed plants as organic manures under different methods of rice establishment. Indian Journal of Agricultural Sciences 64 (3) 184-186.

[39]. Sreenivas 1992: Effect of cultural practices on weed management in rainfed upland rice. Indian Journal of Weed Science 38(2) 119-121.

[40]. Subramanian E, James martin G and Balasubramanian R 2006: Effect of integrated weed management practices on growth and their residual effect on succeeding pulse crop. Indian Journal of Agronomy 51 (2) 93-96.

[41]. Waliya, Yadav and Singh B 2009: Effect of crop establishment method and weed management practice on rice (Oryza sativa) and associated weeds. Indian Journal of Agronomy. 51 (4) 303-303.

[42]. Xiang DH, Ying FR, Fang Li, Ding XH, Fu RY and Fang L 1999: A study on tiller ear bearing of direct seeded rice for yield up to 8.25 t ha\-. China Rice 2 18-19.

[43]. Yeasmin DC and Ye DC 2008: Utilization of tillers in early hybrid rice with different planting methods. China Rice 2 13-15.