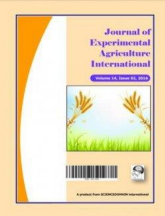

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# Effect of Fertilizers and Irrigation Practices on the Growth and Yield of Boro Rice in *Haor* Area of Bangladesh

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors MSKA and SA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MAK and MAA managed the analyses of the study. Authors MSKA and SA managed the literature searches. All authors read and approved the final manuscript.*

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## ABSTRACT

The experiment was conducted at the farmers' field, Bahadurpur village, Sunamganj Sadar upazila, Sunamganj district, during November 2014 to May 2015 to study the effect of fertilizers and irrigation practices on the growth and yield contributing characters of *boro* rice (cv. BRRI dhan29) in *hao*r area. The experiment comprised two level of fertilizers viz. $F_1$= Farmers' practice based fertilizers (180-42-42 kg $ha^{-1}$ of Urea-TSP-MoP) and $F_2$= BARC recommended fertilizers (300-112-127-75-11 kg $ha^{-1}$ of Urea-TSP-MoP-$CaS0_4$-$ZnS0_4$); and three irrigation practices viz. $I_1$= Farmers' practice, $I_2$= Alternate Wetting and Drying Method, and $I_3$= Wet method. 2x3 factorial fitted into a randomized complete block design (RCBD) experiment was laid out with five farmers' field as replications. The plant height significantly affected due to fertilizers application at 45, 60, 75, 90 Days after transplanting (DAT) and at harvest. BARC recommended dose of fertilizers gave the longer plant

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(87.62 cm) at harvest whereas the shorter plant (83.98 cm) was observed in farmers practice base fertilizer application. Plant height varied significantly due to different irrigation practice at 30 and 90 DAT. The variation of number of total tillers hill$^{-1}$ 30, 45, 60, 75 and 90 DAT and at harvest was significant due to fertilizers application. BARC recommended dose of fertilizers gave the higher tillers number hill$^{-1}$ (16.16) at 75 DAT and the lower number of tillers hill$^{-1}$ (15.00) was noticed in farmers practices base fertilizer application at 75 DAT. The higher grain yield (8.54 t ha$^{-1}$) and straw yield (11.09 t ha$^{-1}$) were recorded due to application of BARC recommended fertilizers over Farmers' practice based fertilizers. Among the three levels of irrigation practices wet irrigation method performed the best in respect of grain yield (8.36 t ha$^{-1}$). The highest grain yield (8.86 t ha$^{-1}$) was observed from the interaction of BARC recommended fertilizers with wet irrigation method. Nutrient contents in post-harvest soils were higher compared to initial soils due to application of BARC recommendation guide based fertilizers. Higher doses of fertilizer treated plots in BARC recommended fertilizers with Wet irrigation method provided the gross margin and highest benefit cost ratio (BCR) among the treatments. The overall results indicated that BARC recommended dose of fertilizers influenced the growth and yield characters of rice varieties (*cv.* BRRI dhan29).

*Keywords: BRRI dhan29; fertilizer; growth; haor; irrigation; yield.*

## 1. INTRODUCTION

Rice is one of the important foods for growing population of human. Rice has the second place because of planted area but it serves as the most important food source for Asian countries mainly in south-east parts where it is an economic crop for farmers and workers who grow it on millions of hectares throughout the region. World rice production at 494.4 million tonnes and total rice growing area (boro, aus and aman) was 11.38 million ha in Bangladesh of which 41.94% covers by the boro rice cultivable area and the production of boro rice was 18.94 million metric tonnes [1]. The people in Bangladesh depend on rice as staple food and have tremendous influence on agrarian economy of the country. Geographic location and agronomic conditions of Bangladesh are favorable for rice cultivation. The average yield of rice is almost less than 50% of the world average rice grain yield. The increasing rate of population is 1.37% and decreasing rate of agricultural land by 1% per annum, limit the horizontal expansion of rice area [2]. Though it is not possible to have horizontal expansion of rice area, so rice yield per unit area should be increased to meet this ever-increasing demand of food in the country. To overcome this situation, increment of rice production per unit area is only the alternative to keep self-sufficiency in food grain production. In the *haor* area of Bangladesh, there is only one cropping season which is rabi season. The *rabi* crops are affected by natural calamities like flash flood, hailstorm and insect pests. The *haor* area is also one of the major economic production zones of the country. *Boro* rice is the most important and single largest crop (90%) in *haor* area. The yield of *boro* rice production per hectare estimated as 3.968 tonnes ha$^{-1}$ in 2013-2014, which is lower than the potential yield in boro season [3]. Rice production system depends on a various management practices such as fertilizers, irrigation, crop management practices, use of high yielding varieties etc. Among them fertilizer is very important input. If the soil nutrient status is not enough to meet up the plant demands, it is necessary to supply the required nutrients to the soil. Judicious use of fertilizers can markedly increase the yield and improve the quality of rice [4]. Wet culture of rice is the normal practice in our cropping practice. It is found that, the conventional flood irrigation for *Boro* rice requires about 3000-5000 liters of water to produce one kilogram of rice, this can be reduced to about 2000 liters by adopting AWD method [5]. About 75 percent of the world's rice is produced using continuous flooding water management practice and the highest yield was obtained in continuous flooding condition [6]. Reduction of water use in rice cultivation is a great challenge throughout the world as well as Bangladesh. *Haor* area of Sunamganj faces critical water crisis during March-April due to irrigation facilities. Water saving technology use may be one of these solutions. The study was aimed to find out the effect of fertilizers and irrigation practices on the growth and yield contributing characters of *boro* rice (cv. BRRI dhan29) in *haor* area.

## 2. MATERIALS AND METHODS

The experimental site was at Bahadurpur village, Sunamganj sadar upazila, Sunamganj district, Bangladesh lies between 24º34" and 25º12"

**Table 1. Irrigation schedule of the experiment were performed during the field study of boro rice (*cv.* BRRI dhan29) in *haor* area**

| No. of irrigation | Date | Farmers' practice | AWD method | Wet irrigation method |
|---|---|---|---|---|
| 1 | 12.01.15 | ✓ | ✓ | ✓ |
| 2 | 19.01.15 | - | - | ✓ |
| 3 | 26.01.15 | ✓ | ✓ | ✓ |
| 4 | 03.02.15 | - | - | ✓ |
| 5 | 10.02.15 | ✓ | ✓ | ✓ |
| 6 | 17.02.15 | - | - | ✓ |
| 7 | 24.02.15 | ✓ | ✓ | ✓ |
| 8 | 03.03.15 | ✓ | - | ✓ |
| 9 | 10.03.15 | ✓ | ✓ | ✓ |
| Total= 9 | | 06 | 05 | 09 |

north latitudes and between 90º56" latitude and 91º49" east longitude. The maximum monthly average air temperature at April 33.5ºC and minimum 14.8ºC at January, maximum monthly average rainfall 121.2 mm in May during monsoon period and no rainfall in the month of November and December, and maximum relative humidity 80.5% during experimental time. The experiment was conducted at the farmers' field during November 2014 to May 2015. The experimental site was located under AEZ-21 having well drainage facility and the soil was clay type. The experiment comprised two level of chemical fertilizer applications *viz.* $F_1$= Farmers' practice based fertilizer (180-42-42 kg $ha^{-1}$ of Urea-TSP-MoP) and $F_2$= BARC recommended fertilizer (300-112-127-75-11 kg $ha^{-1}$ of urea-TSP-MoP-$CaS0_4$-$ZnS0_4$) and three level of irrigation viz. $I_1$= Farmers' practice, $I_2$= Alternate wetting and drying method, and $I_3$= Wet method. The experiment was laid out in a randomized complete block design (RCBD) with five farmers' field replications. The unit plot size was 5.0 m × 4.0 m. The field was prepared by three successive ploughings and cross ploughings with a power tiller and subsequently leveled by laddering. All the fertilizers were applied at the time of final land preparation but Urea was applied in three equal splits at 20, 40 and 60 days after transplanting (DAT) as per treatments. The layout of the field was made after final land preparation. Thirty five days old seedlings were transplanted at the well puddled plots with 2 to 3 seedlings $hill^{-1}$ on 5 January 2015. Intercultural operations such as drainage, gap filling, weeding was done as and when necessary. Some perforated PVC pipes were used to measure the water level below the ground level in the field. The diameter and the length of the PVC pipes were 7 cm and 25 cm, respectively, having 0.5 cm perforations 2 cm away from each other. The pipe was installed in the AWD fields keeping 10 cm above the soil and the remaining portion (15 cm) below the soil for monitoring the water level. The crop of each plot was harvested on from 05 May to 07 May 2015. Data on growth and yield contributing characters were recorded. Initial and post-harvest soils were collected and analyzed to determine the nutrient status. The data were analyzed statistically with the help of computer package program MSAT-C [7]. Finally, economic analyses were done for net benefit and marginal rate of return.

## 3. RESULTS AND DISCUSSION

### 3.1 Growth Parameters

Effects of fertilizers on plant height at 45, 60, 75, 90 DAT and at harvest was significant (Table 2). The longer plant was observed at 45 DAT, 60 DAT, 75 DAT, 90 DAT and at harvest due to application of BARC recommendation guide based fertilizers with respective plant height of 49.82 cm, 68.80 cm, 78.85 cm, 84.94 cm and 87.62 cm, respectively. The shorter plant was observed from application of farmers' practice based fertilizers. Similar result also found by Hossain et al. [8] and Banu et al. [9]. Effect of irrigation practices on plant height of BRRI dhan29 was significantly affected at 30 and 90 DAT but variation of plant height at harvest among the irrigation treatments were not significant (Table 2). Thakur et al. [10] stated that rice plants grown under Alternate Wetting and Drying were 22 and 24% taller than rice plants grown under continuous flood. The number of total tillers $hill^{-1}$ was significantly varied due to application of fertilizer dose at 30, 45, 60, 75 and 90 DATs and at harvest (Table 3). The highest number of total tillers $hill^{-1}$ (16.16) was produced

**Table 2. Effect of fertilizers and irrigation practices on the plant height of *boro* rice (*cv.* BRRI dhan29) in the *haor* area**

| Treatment | Plant height (cm) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Days after transplanting (DAT) | | | | | | |
| | 15 | 30 | 45 | 60 | 75 | 90 | At harvest |
| **Fertilizer** | | | | | | | |
| $F_1$ | 33.37 | 37.69 | 46.30 | 62.71 | 72.11 | 83.98 | 83.98 |
| $F_2$ | 32.92 | 37.16 | 49.82 | 68.80 | 78.85 | 84.94 | 87.62 |
| LS | NS | NS | ** | ** | ** | ** | ** |
| **Irrigation** | | | | | | | |
| $I_1$ | 33.34 | 36.82 b | 47.48 | 64.86 | 74.66 | 81.60 b | 86.18 |
| $I_2$ | 32.26 | 37.52 ab | 48.24 | 66.68 | 75.46 | 83.84 ab | 84.86 |
| $I_3$ | 33.84 | 37.94 a | 48.48 | 65.72 | 76.32 | 84.23 a | 86.37 |
| LS | NS | * | NS | NS | NS | ** | NS |
| LSD Value | - | 0.94 | - | - | - | 5.90 | - |
| **Interaction of fertilizer and irrigation** | | | | | | | |
| $F_1I_1$ | 32.84 | 36.12 | 45.32 | 61.08 | 69.80 | 82.72 | 83.82 |
| $F_1I_2$ | 32.52 | 37.76 | 46.40 | 63.72 | 73.16 | 80.24 | 83.52 |
| $F_1I_3$ | 34.76 | 39.20 | 47.20 | 63.32 | 73.36 | 81.54 | 84.60 |
| $F_2I_1$ | 33.84 | 37.52 | 49.64 | 68.64 | 79.52 | 85.74 | 88.54 |
| $F_2I_2$ | 32.00 | 37.28 | 50.08 | 69.64 | 77.76 | 82.96 | 86.20 |
| $F_2I_3$ | 32.92 | 36.68 | 49.76 | 68.12 | 79.28 | 86.14 | 88.14 |
| LS | NS | NS | NS | NS | NS | NS | NS |
| LSD Value | - | - | - | - | - | - | - |

*** = Significant at 1% level of provability; * = Significant at 5 % level of provability; SD=Standard deviation; LS = Level of significance; CV = Coefficient of Variation; NS = Not significant; $F_1$ = Farmers' practice based fertilizers (180-42-42 kg ha$^{-1}$ of urea-TSP-MoP); $F_2$ = BARC recommendation guide based fertilizers (300-112-127-75-11 kg ha$^{-1}$ of urea-TSP-MoP-$CaS0_4$-$ZnS0_4$); $I_1$ = Farmers' practice of irrigation; $I_2$ = Alternate Wetting and Drying (AWD) method of irrigation; $I_3$ = Wet irrigation method*

**Table 3. Effect of fertilizers and irrigation practices on number of total tillers hill$^{-1}$ of *boro* rice (*cv.* BRRI dhan29) in the *haor* area**

| Treatment | Number of total tillers hill$^{-1}$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | Days after transplanting ( DAT) | | | | | | |
| | 15 | 30 | 45 | 60 | 75 | 90 | At harvest |
| **Fertilizer** | | | | | | | |
| $F_1$ | 5.64 | 11.40 | 14.69 | 14.96 | 15.00 | 14.67 | 14.52 |
| $F_2$ | 5.47 | 12.19 | 16.12 | 16.12 | 16.16 | 15.83 | 15.73 |
| LS | NS | * | ** | ** | ** | ** | ** |
| **Irrigation** | | | | | | | |
| $I_1$ | 5.20 | 11.62 | 15.10 | 15.30 | 15.34 | 14.96 | 14.82 |
| $I_2$ | 5.98 | 11.88 | 15.94 | 15.94 | 15.98 | 15.70 | 15.58 |
| $I_3$ | 5.48 | 11.88 | 15.18 | 15.38 | 15.44 | 15.08 | 14.98 |
| LS | NS | NS | NS | NS | NS | NS | NS |
| LSD Value | - | - | - | - | - | - | - |
| **Interaction of fertilizer and irrigation** | | | | | | | |
| $F_1I_1$ | 5.40 | 11.56 | 14.12 | 14.52 | 14.46 | 14.12 | 13.96 |
| $F_1I_2$ | 6.00 | 11.08 | 15.20 | 15.20 | 15.26 | 14.96 | 14.76 |
| $F_1I_3$ | 5.52 | 11.56 | 14.76 | 15.16 | 15.24 | 14.92 | 14.84 |
| $F_2I_1$ | 5.00 | 11.68 | 16.08 | 16.08 | 16.20 | 15.80 | 15.68 |
| $F_2I_2$ | 5.96 | 12.68 | 16.68 | 16.68 | 16.80 | 16.44 | 16.40 |
| $F_2I_3$ | 5.44 | 12.20 | 15.60 | 15.60 | 15.64 | 15.24 | 15.12 |
| LS | NS | NS | NS | NS | NS | NS | NS |
| LSD Value | - | - | - | - | - | - | - |

*** = Significant at 1% level of provability; * = Significant at 5 % level of provability; LS = Level of Significance; CV = Coefficient of Variation; NS = Not significant; $F_1$ = Farmers' practice based fertilizers (180-42-42 kg ha$^{-1}$ of urea-TSP-MoP); $F_2$ = BARC recommendation guide based fertilizers (300-112-127-75-11 kg ha$^{-1}$ of urea-TSP-MoP-$CaS0_4$-$ZnS0_4$); $I_1$ = Farmers' practice of irrigation; $I_2$ = Alternate Wetting and Drying (AWD) method of irrigation; $I_3$ = Wet irrigation method.*

due to application of BARC recommendation guide based fertilizers. This finding was similar of the findings of Gangwar et al. [11]. From the above result, it was observed that in most cases, the growth character named plant height and number of total tillers hill$^{-1}$ was significantly affected due to the application of BARC recommendation guide based fertilizers compared to Farmers' practice.

## 3.2 Yield Parameters

Yield and yield contributing characters were influenced significantly due to application of different fertilizers practices (Table 4). The higher number of effective tillers hill$^{-1}$ (14.65), number of grains panicle$^{-1}$ (178.20), number of sterile spikelets panicle$^{-1}$ (43.31), panicle length (23.86 cm), 1000-grains weight (23.37 g), grain yield (8.54 t ha$^{-1}$) and straw yield (09.66 t ha$^{-1}$) were obtained due to application of BARC recommended fertilizers in comparison to farmers practices. The similar result was also found by Hossain et al. [8], BRRI [12] and Islam et al. [13]. Irrigation practices were influenced significantly the number of grains panicle$^{-1}$ and grain yield (Table 4). The highest number of grains panicle$^{-1}$ (173.42) and grain yield (8.36 t ha$^{-1}$) were obtained due to Wet irrigation method ($I_3$). While the lowest number of grains panicle$^{-1}$ (161.72) and grain yield (7.80 t ha$^{-1}$) were obtained due to Farmers' practice of irrigation ($I_1$). Similar result found by Maiti et al. [14] in their field experiment in West Bangal, India. Interaction effect of fertilizers and irrigation practices was significant in number of grains panicle$^{-1}$ (Table 4). The highest number of grains panicle$^{-1}$ (191.12) was obtained due to BARC recommended fertilizers with Wet irrigation method ($F_2I_3$). Hossain and Alam [15], Ali et al. [16] and Rajput et al. [17] was also found the similar result. BARC Recommended dose of fertilizers significantly affected the yield and yield contributing characters of boro rice (cv. BRRI dhan29).

**Table 4. Effect of fertilizer, irrigation practice and their interaction on yield and yield contributing characters of *boro* rice (*cv.* BRRI dhan29) in the *haor* area**

| Treatment | Effective tillers hill$^{-1}$ (no.) | Grains panicle$^{-1}$ (no.) | Sterile spikelets panicle$^{-1}$ (no.) | Panicle length (cm) | 1000-grains weight (g) | Grain yield (t ha$^{-1}$) | Straw yield (t ha$^{-1}$) |
|---|---|---|---|---|---|---|---|
| **Fertilizer** | | | | | | | |
| $F_1$ | 13.52 | 153.54 | 36.93 | 22.66 | 22.67 | 7.70 | 08.96 |
| $F_2$ | 14.65 | 178.20 | 43.31 | 23.86 | 23.37 | 8.54 | 09.66 |
| LS | ** | ** | ** | ** | ** | ** | ** |
| **Irrigation** | | | | | | | |
| $I_1$ | 13.82 | 161.72 bc | 39.14 | 23.01 | 22.80 | 7.80 b | 08.85 |
| $I_2$ | 13.06 | 162.47 b | 40.52 | 23.08 | 23.10 | 8.20 ab | 09.43 |
| $I_3$ | 14.53 | 173.42 a | 40.69 | 23.69 | 23.15 | 8.36 a | 09.46 |
| LS | NS | ** | NS | NS | NS | ** | NS |
| LSD Value | - | 4.90 | - | - | - | 0.28 | - |
| **Interaction of fertilizer and irrigation** | | | | | | | |
| $F_1I_1$ | 12.96 | 148.48 f | 35.92 | 22.22 | 22.20 | 7.51 | 08.85 |
| $F_1I_2$ | 13.70 | 156.42 d | 38.22 | 22.42 | 22.90 | 7.74 | 09.22 |
| $F_1I_3$ | 13.78 | 155.72 de | 36.64 | 23.34 | 22.90 | 7.85 | 09.06 |
| $F_2I_1$ | 14.56 | 174.96 b | 42.36 | 23.80 | 23.40 | 8.08 | 09.96 |
| $F_2I_2$ | 15.23 | 168.52 c | 42.82 | 23.74 | 23.30 | 8.67 | 10.04 |
| $F_2I_3$ | 14.08 | 191.12 a | 44.74 | 24.04 | 23.40 | 8.86 | 10.26 |
| LS | NS | ** | NS | NS | NS | NS | NS |
| LSD Value | - | 14.62 | - | - | - | - | - |

*LS = Level of Significance; CV = Coefficient of Variation, ** = Significant at 1 % level of provability; $F_1$ = Farmers' practice (180-42-42 kg ha$^{-1}$ of Urea-TSP-MoP); $F_2$ = BARC recommendation guide based fertilizers (300-112-127-75-11 kg ha$^{-1}$ of urea-TSP-MoP-CaS0$_4$-ZnS0$_4$); $I_1$ = Farmers' practice of irrigation, $I_2$ = Alternate Wetting and Drying (AWD) method of irrigation; $I_3$ = Wet irrigation method*

**Table 5. Nutrients status of initial and post-harvest soil of experimental field in the Bahadurpur village of Dekar *haor* area**

| Treatment | pH | Total-N % | OM % | K meq100 $g^{-1}$ | P ppm | S ppm | Zn ppm |
|---|---|---|---|---|---|---|---|
| **Initial soil** | | | | | | | |
| | 4.80 | 0.11 | 2.9 | 0.16 | 4.00 | 24 | 1.87 |
| **post-harvest soil ( fertilizers and irrigation practice)** | | | | | | | |
| $F_1I_1$ | 4.50 | 0.13 | 2.84 | 0.19 | 4.85 | 25 | 1.88 |
| $F_1I_2$ | 4.46 | 0.13 | 3.21 | 0.20 | 5.20 | 36 | 1.96 |
| $F_1I_3$ | 4.47 | 0.13 | 3.56 | 0.20 | 5.16 | 34 | 2.03 |
| $F_2I_1$ | 4.34 | 0.14 | 2.98 | 0.21 | 5.00 | 27 | 1.92 |
| $F_2I_2$ | 4.49 | 0.14 | 3.56 | 0.22 | 5.33 | 38 | 2.17 |
| $F_2I_3$ | 4.59 | 0.15 | 3.70 | 0.23 | 5.40 | 40 | 2.30 |

*OM = Organic matter; $F_1$ = Farmers' practice (180-42-42 kg $ha^{-1}$ of Urea-TSP-MoP); $F_2$ = BARC recommendation guide based fertilizers (300-112-127-75-11 kg $ha^{-1}$ of urea-TSP-MoP-$CaS0_4$-$ZnS0_4$); $I_1$ = Farmers' practice of irrigation; $I_2$ = Alternate Wetting and Drying (AWD) method of irrigation; $I_3$ = Wet irrigation method*

**Table 6. Agro-economic analysis of BRRI dhan29 grower under different fertilizer and irrigation practices in the Dekar *haor* area**

| Fertilizer and Irrigation practice | Cost of cultivation (Tk $ha^{-1}$) | Gross return (Tk $ha^{-1}$) | Gross margin (Tk $ha^{-1}$) | BCR |
|---|---|---|---|---|
| $F_1I_1$ | 43799 | 125925 | 82126 | 2.88 |
| $F_1I_2$ | 46580 | 136140 | 89560 | 2.92 |
| $F_1I_3$ | 43937 | 129930 | 85993 | 2.96 |
| $F_2I_1$ | 44267 | 131340 | 87073 | 2.97 |
| $F_2I_2$ | 48670 | 145110 | 96440 | 2.98 |
| $F_2I_3$ | 49215 | 148290 | 99075 | 3.01 |

*BCR= Benefit Cost Ratio; Gross returns included income from sale of main and by-products (Tk $ka^{-1}$) of crop, Grain @ 15 Tk. $kg^{-1}$; Straw @ 1.5 Tk. $kg^{-1}$. Among field operations, the cost of ploughing was taken as Tk. 10 $decimal^{-1}$, labour cost of Tk. 300 $m^{-1}day^{-1}$, Urea @ 20 Tk. $kg^{-1}$; TSP @ 25 Tk. $kg^{-1}$; MoP @ 17 Tk. $kg^{-1}$*

## 3.3 Chemical Properties of Experimental Soil

Chemical properties before and after cropping was changed due to fertilizers application (Table 5). The pH value was reduced in post-harvest soils in comparison to initial soil. Post-harvest soils nutrients such as total N%, soil organic matter %, available P (ppm), exchangeable K(meq100 $g^{-1}$), available S (ppm), and available Zn (ppm) were higher due to application of BARC recommendation guide based fertilizers treated plots compared to Farmers' practiced plots. It was due to balanced nutrient supply which ensured by the BARC recommendation guide based fertilizers application. The study region occupies the lower, western side of the Surma-Kushiyara Floodplain. The area is mainly smooth, broad basins with narrow rims of higher land along rivers i.e. AEZ-21. Soils of the area are grey, silty clay loams and clay loam in the higher parts that dry out seasonally and grey clays in the *wet* basins, BARC [18]. This finding was similar of the findings of Maiti et al. [19].

## 3.4 Agro-Economic Analysis of BRRI Dhan29 Grower

Gross return was calculated from the price of rice grain and straw. Costs that vary were calculated from the cost involved for input used for the experimental treatments. The budget analysis of cost of production showed that the highest cost of cultivation (Tk. 49215 $ha^{-1}$); gross return (Tk. 148290 $ha^{-1}$) and gross margin (Tk. 99075 $ha^{-1}$) was accounted for BARC recommended fertilizers with Wet irrigation method ($F_2I_3$) because of higher yield though higher cost was involved (Table 6). Higher doses of fertilizer treated plots in BARC recommended fertilizers with Wet irrigation method ($F_2I_3$) provided the highest benefit cost ratio (BCR) among the treatments. Similar result was also observed by Aziz et al. [20].

## 4. CONCLUSION

Geographic location and agronomic conditions of Bangladesh are favorable for rice cultivation. The results revealed in the study indicated that the yield and yield contributing characters were performed best due to application of BARC recommendation based fertilizers with Wet method of irrigation Bahadurpur village in Dekar *haor* under AEZ-21 of Sunamganj Sadar Upazila, Sunamganj district during Boro season. Rice production per unit area is only the alternative to keep self-sufficiency in food grain production in *haor* area of Bangladesh. Farmers' of the *haor* area might be suggested both to apply BARC recommendation based fertilizers and Alternate wetting and drying for getting higher yield of boro rice (*cv.* BRRI dhan29) in the *haor* area.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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