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Effect of Plant Growth Regulator-Flora on the Growth and Yield of Transplanted Aman Rice

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Abstract

The experiment was conducted in the farm area of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka during the period of July to November, 2015 to find out the effect of plant growth regulator-flora on the growth and yield of transplanted aman rice (BR 11-Mukta). The experiment comprised of 8 treatments as- T_0: Control condition (No chemical fertilizer, no Flora), T_1: Recommended Fertilizer Doses-RFD (120, 20, 80, 16 and 2 kg ha^{-1} of N, P, K, S and Zn, respectively), T_2: RFD+1 time spray of Flora, T_3: RFD+2 times spray of Flora, T_4: ½ RFD+1 time spray of Flora, T_5: ½ RFD+2 times spray of Flora, T_6: No chemical fertilizer+1 time spray of Flora and T_7: No chemical fertilizer+2 times spray of Flora. Data on different yield contributing characters, yield, and characteristics of post-harvest soil was recorded and significant variation was observed for different treatments. At harvest, the tallest plant (117.60 cm) was recorded from T_3, while the shortest plant (88.85 cm) in T_0 treatment. The highest number of filled grains panicle^{-1} (86.27) was recorded in T_3, whereas the lowest number (68.53) in T_0 treatment. The highest grain yield (5.13 t ha^{-1}) was recorded in T_3, while the lowest (2.78 t ha^{-1}) in T_0 treatment. The highest total nitrogen (0.632%) was recorded from T_3, while the lowest (0.369%) in T_0 treatment.

Keywords: Plant growth regulator, flora, yield, growth, transplanted aman

1. Introduction

Rice (*Oryza sativa* L.) is the world's most important staple food; it can support more than half of the world's population (Davidson et al., 2014). In worldwide, 474.86 million metric tons of rice was produced from 159.64 million hectares of land during the year of 2014-15 (Anonymous, 2015). Global rice production in 2016 was up to about 749 million t, superseded by maize with a yield of 959 million t (Wang et al., 2017). About 84.67% of cropped area of Bangladesh is used for rice production, with annual production of 30.42 million tons from 10.4 million hectare of land (Anonymous, 2014). Among different rice growing seasons, transplant aman cover about 49.11% and it contributes to 38.11% of the total rice production in the country (Anonymous, 2014). Rice yields are either decelerating/stagnating/declining in post green revolution era mainly due to imbalance in fertilizer use, soil degradation, irrigation and weeding schedule, type of cropping system practiced, lack of suitable rice

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variety for low moisture adaptability and disease resistance (Prakash, 2010).

Now day's different high yielding and hybrid rice varieties are available in Bangladesh which has more yield potentiality (Bhuiyan et al., 2014). At present there is a very little scope for horizontal expansion of rice production in Bangladesh. So the farmers and agricultural scientists are diverting their attention towards vertical expansion for increased crop production. Nowadays, it is therefore crucial to boost rice yield in limited cultivated land area per capita to meet the food demands of the increasing worldwide population. Several alternative counter-measures, including developing water conservancy projects, ameliorating soil qualities, popularizing techniques of plant protection and cultivation as well as the application of fertilizers have been implemented (Yuan, 2014). Therefore, attempts should be taken to increase the yield per unit area through the use of modern production technologies that included, use of quality seeds, high yielding and hybrid varieties, optimum age of seedling, optimum number of seedling hill^{-1}, adopting proper plant protection measures, seedling raising techniques and fertilizer management. In Bangladesh, on an average to produce one ton of rice grain of high-yielding varieties is removed about 22 kg N, 7 kg P_2O_5, 32 kg K_2O, 5 kg MgO, 4 kg CaO, 1 kg S and 40 g Zn from the soil (Chaudhary et al., 2007). Emergence of widespread multi-nutrient deficiencies, depletion of native nutrient reserves, imbalanced fertilization are of utmost concern, causing serious stagnation in yields and declining productivity of various rice ecosystems (Rai, 2006). Excess use of fertilizer nutrients implies increase of cost and decreases of returns and risk of environmental and soil pollution (Sharma et al., 2003). The combination of inefficiency and excess fertilizer use has adverse impacts on water, soil, climate and biodiversity (Ma et al., 2014). On the other hand, under use of nutrients depress the scope for increasing the present level of nutrients to the economically optimum level to exploit production potential to a larger extent (Singh et al., 2001). So, application of inadequate and unbalanced fertilization to crops is the results of low crop yields.

Plant growth regulators (PGRs) are organic compounds, other than nutrients that modify plant physiological processes and also called biostimulants or bioinhibitors that act inside plant cells to stimulate or inhibit specific enzymes or enzyme systems and thus regulate plant metabolism (Rahman et al., 2017). Flora is a plant growth regulator containing 20% Nitro Benzene and acts as a plant energizer, flowering stimulant and yield booster. The use of plant growth regulator (PGR) in rice in Bangladesh is very little so the requirement is to properly understand the PGR to enhance high yield and quality. Suitable PGR are necessary for sustainable agriculture that will provide maximum rice production with good quality (Aziz and Miah, 2009). The PGRs regulated N_2O transport by manipulating anatomical and physiological processes and its application can be suitable for N_2O emission reduction coupled with an increase in economic productivity (Mohapatra et al., 2018). PGR have now been applied to a large variety of plant organs in several ways and it has been found to greatly enhance stem elongation as its most striking effect. They act inside plant cells and play important roles in plant growth, yield and quality formation of crops (Ekamber and Kumar, 2007). PGR increase the active Fe content in leaves and alleviate rice chlorosis in practical use (Zhang et al., 2017). Furthermore, PGRs regulate the amount, type and direction of plant growth with remarkable accomplishments of improved plant development and enhanced yield in several crops been documented (Shah et al., 2006; Emongor, 2007). It regulates cell elongation, tissue swelling, cell division and formation of adventitious roots, among others (Woodward and Bartel, 2005; Abel and Theologis, 2010) and also participates in the regulation of growth and development processes (Sakamoto et al., 2004; Mohammed and Tarpley, 2011; Fahad et al., 2015). PGR increases 14.3% increase in the number of rice panicles (Banful and Attivor, 2017). Application of PGR Partially alleviated the detrimental effects of rice senescence by modulating the activity of enzymatic antioxidants, and improving antioxidant system, which helped in sustaining plant growth (Pan et al., 2013). Based on above discussion the research work was designed with the objective to evaluate the growth and yield of transplanted aman rice due plant growth regulators-flora.

2. Materials and Methods

2.1. Experimental period and location

The experiment was conducted during the period of July to November, 2015 in the farm area of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka. The location of the site is $23^0 74'$N latitude and $90^0 35'$E longitude with an elevation of 8.4 meter above from sea level.

2.2. Soil characteristics

The land type of the experimental soil were high land with general soil type is Shallow Red Brown Terrace soil and the soil belongs to the Tejgaon series under the Agro-ecological Zone of Madhupur Tract (AEZ-28). A composite sample of the experimental field was made by collecting soil from several spots of the field at a depth of 0-15 cm before initiation of the experiment. The collected soil was air-dried, grind and passed through 2 mm sieve and analyzed at Soil Resources Development Institute (SRDI), Farmgate, Dhaka for some important physical and chemical properties. The soil was having a texture of silty clay with pH and organic matter 6.31 and 1.31%, respectively. The results showed that the soil composed of 27% sand, 43% silt and 30% clay. In the soil, the total N (%), available P (ppm), exchangeable K (me/100 g soil) and available S (ppm) were 0.06%, 19.85 ppm, 0.12 me/100 g soil and 14.40 ppm respectively.

2.3. Planting material and treatment of the experiment

In this experiment BR 11 (Mukta) was used as the test crop which was developed at the Bangladesh Rice Research

Institute from the cross between BR 52-87-1-HR88 and IR20/IR5-47-2 in 1980.

The experiment comprised of the following 8 treatment:

T_0: Control condition (No chemical fertilizer, no Flora), T_1: Recommended Fertilizer Doses-RFD (120, 20, 80, 16 and 2 kg ha^{-1} of N, P, K, S and Zn, respectively), T_2: RFD + 1 time spray of Flora, T_3: RFD+2 times spray of Flora, T_4: ½ RFD + 1 time spray of Flora, T_5: ½ RFD+2 times spray of Flora, T_6: No chemical fertilizer + 1 time spray of Flora,T_7: No chemical fertilizer + 2 times spray of Flora

2.4. Experimental design

The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. An area of 29.5×14.5 m^2 was divided into 3 blocks. The size of the each unit plot was 3.5 ×2.5 m^2. The space between two blocks and two plots were 0.75 m and 0.5 m, respectively.

2.5. Fertilizers and manure application

The fertilizers N, P, K, S and Zn in the form of urea, TSP, MoP, Gypsum and zinc sulphate, respectively were applied @ 120 kg, 20 kg, 80 kg, 16 kg and 2.0 kg ha^{-1}. The entire amounts of TSP, MoP, gypsum and zinc sulphate were applied during the final preparation of experimental plot. Urea was applied in two equal installments as top dressing at tillering and panicle initiation stages.

2.6. Application of PGR-Flora

PGR-Flora was collected from Siddique Bazaar, Dhaka and applied as per treatment with mixing 2.0 ml Flora with 500 ml water for per plot. 1st spray was done at 5 September and 2nd spray at 20 September, 2015 in the specific plot as per treatment.

2.5. Sampling and data collection

Data on different parameters were counted from 10 selected hills and average value was recorded. After harvest of crop soil samples were collected from each plot at a depth of 0 to 15 cm. Soil samples of each plot was air-dried, crushed and passed through a two mm (10 meshes) sieve. Data on different yield contributing characters, yield and nutrient status of post-harvest soil were statistically analyzed.

3. Results and Discussion

3.1. Yield attributes and yield of rice

Statistically significant variation was recorded in terms of different yield attributes and yield of rice due to the effect of different treatments (Table 1). At 40 DAT, the longest plant (25.76 cm) was observed in T_3 (RFD+2 times spray of Flora) which was statistically similar (25.33 cm, 24.32 cm, 23.29 cm, 22.27 cm, 22.00 cm and 21.44 cm, respectively) to T_2 (RFD+1 time spray of Flora), T_1 (Recommended Fertilizer Doses-RFD: 120, 20, 80, 16 and 2 kg ha^{-1} of N, P, K, S and Zn, respectively), T_5 (½ RFD + 2 times spray of Flora), T_4 (½ RFD+1 time spray of Flora), T_7 (No chemical fertilizer+2 times spray of Flora) and T_6 (No chemical fertilizer+1 time spray of Flora), whereas the shortest plant (18.60 cm) was observed in T_0 (Control condition i.e. no chemical fertilizer, no flora) treatment. Similar tends of results also recorded at 50, 60 and 70 DAT. At harvest, the tallest plant (117.60 cm) was recorded from T_3 treatment, which was statistically similar with other treatment except T_0, while the shortest plant (88.85 cm) was found in T_0 treatment. Generally plant height is a genetical character and it is controlled by the genetic make-up of the varieties and different varieties produced different size of plant but management practices also influenced it. Ndaeyo et al. (2008) reported that NPK (15:15:15) fertilizer rate significantly increased plant height.

Table 1: Effect of plant growth regulator-flora on plant height at different days after transplanting (dat) and harvest of transplanted aman rice

Treatments	Plant height (cm) at				
	40 DAT	50 DAT	60 DAT	70 DAT	Harvest
T_0	18.60^{b}	41.90^{d}	62.96^{c}	73.27^{d}	88.85^{b}
T_1	24.32^{a}	51.76^{a-c}	79.97^{ab}	91.96^{a-c}	112.80^{a}
T_2	25.33^{a}	52.73^{ab}	81.61^{ab}	93.51^{ab}	115.00^{a}
T_3	25.76^{a}	54.24^{a}	83.42^{a}	97.81^{a}	117.60^{a}
T_4	22.27^{ab}	48.24^{bc}	74.37^{a-c}	85.59^{bc}	108.56^{a}
T_5	23.29^{a}	49.33^{a-c}	76.55^{ab}	88.91^{a-c}	110.56^{a}
T_6	21.44^{ab}	46.73^{cd}	70.51^{bc}	82.03^{cd}	107.19^{a}
T_7	22.00^{ab}	47.62^{bc}	73.83^{a-c}	83.70^{bc}	109.25^{a}
LSD (p=0.05)	3.906	5.047	10.66	9.435	10.07
Significance level	0.05	0.01	0.05	0.01	0.01

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

The highest number of effective tillers $hill^{-1}$ (16.13) was found in T_3 which was statistically similar (15.80, 15.33, 14.73, 14.60 and 14.20, respectively) to T_2, T_1, T_5, T_7 and T_4, and closely followed (13.87) by T_6, while the lowest number of effective tillers $hill^{-1}$ (10.27) was recorded in T_0 treatment (Table 2). The lowest number of ineffective tillers $hill^{-1}$ (2.27) was observed in T_3 which was statistically similar (2.40) to T_2 and closely followed (2.67) by T_1. On the other hand, the highest number (4.33) was found in T_0 treatment. The highest number of total tillers $hill^{-1}$ (18.40) was found in T_3 which was statistically similar with other treatment except T_0, while the lowest number of total tillers $hill^{-1}$ (14.60) was observed in T_0 treatment. Ndaeyo et al. (2008) reported that NPK (15:15:15) fertilizer rate significantly increased tillers per plant. The highest number of filled grains $panicle^{-1}$ (86.27) was recorded in T_3 which was statistically similar (84.27, 81.73,

Table 2: Effect of plant growth regulator-flora on yield contributing characters of transplanted aman rice

Treatments	No. of effective tillers hill^{-1}	No. of in-effective tillers hill^{-1}	No. of total tillers hill^{-1}	No. of filled grains panicle^{-1}	No. of unfilled grains panicle^{-1}	No. of total grains panicle^{-1}
T_0	10.27^{c}	4.33^{a}	14.60^{b}	68.53^{c}	9.67^{a}	78.20 b
T_1	15.33^{ab}	2.67^{d}	18.00^{a}	81.67^{ab}	7.13^{b-d}	88.80^{a}
T_2	15.80^{ab}	2.40^{de}	18.20^{a}	84.27^{ab}	6.60^{cd}	90.87^{a}
T_3	16.13^{a}	2.27^{e}	18.40^{a}	86.27^{a}	6.13^{d}	92.40^{a}
T_4	14.20^{ab}	3.20^{c}	17.40^{a}	80.20^{ab}	7.27^{b-d}	87.47^{a}
T_5	14.73^{ab}	3.07^{c}	17.80^{a}	81.73^{ab}	7.00^{b-d}	88.73^{a}
T_6	13.87^{b}	3.67^{b}	17.53^{a}	77.60^{b}	8.20^{b}	85.80^{ab}
T_7	14.60^{ab}	3.33^{c}	17.93^{a}	79.40^{ab}	7.60^{bc}	87.00^{a}
LSD (p=0.05)	1.963	0.271	2.130	7.367	1.150	7.799
Significance level	0.01	0.01	0.05	0.01	0.01	0.05

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

81.67, 80.20 and 79.40, respectively) to T_2, T_5, T_1, T_4 and T_7, and closely followed (77.60) by T_6, whereas the lowest number of filled grains panicle^{-1} (68.53) was found in T_0 treatment. The lowest number of unfilled grains panicle^{-1} (6.13) was observed in T_3 which was statistically similar (6.60, 7.13 and 7.27, respectively) to T_2, T_1 and T_4, whereas the highest number of unfilled grains panicle^{-1} (9.67) was found in T_0 treatment. The highest number of total grains panicle^{-1} (92.40) was found in T_3 which was statistically similar with other treatments except T_0, while the lowest number of total grains panicle^{-1} (78.20) was recorded in T_0 treatment. Vetayasuporn (2012) reported that chemical fertilizer) which gave the highest total number panicle per hill (14.82).

The longest panicle (25.78 cm) was observed in T_3 which was statistically similar (25.05 cm, 24.37 cm and 23.95, respectively) to T_2, T_1 and T_5, and closely followed (22.61) by T_4, whereas the shortest panicle (18.79 cm) was observed in T_0 treatment which was statistically similar (20.16 cm and 21.16 cm) to T_6 and T_7 and they were statistically similar (Table 3). The highest weight of 1000 grains (20.92 g) was recorded in T_3 which was statistically similar with other treatment except T_0, while the lowest weight of 1000 grains (18.03 g) was observed in T_0 treatment. The highest grain yield (5.13 t ha^{-1}) was recorded in T_3 which was followed (4.41, 4.24 and 4.05 t ha^{-1}) by T_2, T_1 and T_5, respectively, while the lowest grain yield (2.78 t ha^{-1}) was observed in T_0 treatment. Haq et al. (2002) reported that 90 kg N + 50 kg P_2O_5 + 40 kg K_2O + 10 kg S + 4 kg Zn ha^{-1} + diazinon gave the highest grain yields. Rahman (2017) reported that in rice-rice cropping pattern, the highest grain yield of Boro rice was recorded in the soil test basis (STB) N P K S Zn fertilizers treatment while in T. Aman rice the 75% or 100% of N P K S Zn (STB) fertilizers plus green manure (GM) with or without cowdung gave the highest or a comparable yield. The highest straw yield (5.31 t ha^{-1}) was found in T_3 which was statistically similar (5.15, 5.06 and 4.82 t ha^{-1}) to T_2, T_1 and T_5, respectively, where the lowest straw yield (4.32 t ha^{-1}) was recorded in T_0 treatment which was statistically similar (4.39 t ha^{-1} and 4.53 t ha^{-1}) to T_6 and T_4 treatment. Haq et al. (2002) reported that 90 kg N+50 kg P_2O_5+40 kg K_2O+10 kg S+4 kg Zn ha^{-1}+diazinon gave the highest straw yields. The highest biological yield (10.44 t ha^{-1}) was recorded in T_3 which was statistically similar (9.56, 9.30 and 8.88 t ha^{-1}) to T_2, T_1 and T_5, respectively and closely followed (8.29 t ha^{-1}) by T_4, while the lowest biological yield (7.10 t ha^{-1}) was observed in T_0 treatment which was statistically similar (7.71 t ha^{-1} and 7.97 t ha^{-1}) to T_6 and T_7 treatment (Table 3). The highest harvest index (46.31%) was found in T_3 which was statistically similar with other treatment except T_1 and T_7 and closely followed (42.78%) by T_7 and the lowest harvest index (39.18%) was obtained in T_0 treatment.

3.2. Soil pH, organic matter total N, available P and exchangeable K in post-harvest soil

Different post-harvest soil characteristics showed statistically differences due to the effect of different treatments (Table 4). The highest soil pH (6.15) was found from T_3 treatment, whereas the lowest soil pH (5.73) was observed from T_0 treatment. The highest organic matter (1.46%) was recorded from T_3 treatment and the lowest organic matter (1.33%) was found from T_0 treatment. The highest total nitrogen (0.632%) was recorded from T_3 treatment which was statistically similar with other treatmnet except T_0 and T_6, while the lowest total nitrogen (0.369%) was observed from T_0 treatment. The highest available phosphorus (32.59%) was recorded from T_3 treatment which was statistically similar (31.92%, 30.11% and 29.19%, respectively) to T_2, T_1 and T_5, whereas the lowest available phosphorus (16.54%) was obtained from T_0 treatment. The highest exchangeable potassium (0.169 me %) was observed from T_3 treatment which was statistically similar with other treatment except T_0 and T_6, while the

Table 3: Effect of plant growth regulator-flora on yield contributing characters and yield of transplanted aman rice

Treatments	Length of panicle (cm)	Weight of 1000 grains (g)	Grain yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index (%)
T_0	18.79^{d}	18.03^{b}	2.78^{e}	7.10^{d}	39.18^{c}
T_1	24.37^{ab}	20.44^{a}	4.24^{bc}	9.30^{a}	45.46^{ab}
T_2	25.05^{ab}	20.65^{a}	4.41^{b}	9.56^{a}	46.15^{a}
T_3	25.78^{a}	20.92^{a}	5.13^{a}	9.88^{a}	46.31^{a}
T_4	22.61^{bc}	19.68^{ab}	3.77^{cd}	8.29^{bc}	45.37^{ab}
T_5	23.95^{ab}	20.16^{a}	4.05^{bc}	8.88^{ab}	45.68^{ab}
T_6	20.16^{cd}	19.21^{ab}	3.33^{d}	7.71^{cd}	43.11^{ab}
T_7	21.16^{cd}	19.38^{ab}	3.41^{d}	7.97^{bcd}	42.78^{b}
LSD (p=0.05)	2.605	1.679	0.508	0.933	2.950
Significance level	0.01	0.05	0.01	0.01	0.01

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

Table 4: Effect of plant growth regulator-flora on nutrient content of post-harvest soil of transplanted aman rice

Treatments	pH	Organic matter (%)	Total N (%)	Available P (ppm)	Exchangeable K (me %)
T_0	5.73	1.33	0.369^{c}	16.54^{e}	0.084^{c}
T_1	6.05	1.44	0.624^{a}	30.11^{ab}	0.160^{ab}
T_2	6.13	1.45	0.629^{a}	31.92^{a}	0.165^{a}
T_3	6.15	1.44	0.632^{a}	32.59^{a}	0.169^{a}
T_4	5.89	1.41	0.596^{ab}	28.32^{bc}	0.151^{ab}
T_5	5.94	1.41	0.613^{ab}	29.19^{ab}	0.160^{ab}
T_6	5.85	1.40	0.556^{b}	22.75^{d}	0.141^{b}
T_7	5.89	1.43	0.581^{ab}	25.55^{cd}	0.151^{ab}
LSD (p=0.05)	--	--	0.055	3.331	0.018
Significance level	NS	NS	0.01	0.01	0.01

In a column means having similar letter(s) are statistically identical and those having dissimilar letter(s) differ significantly as per 0.05 level of probability

lowest exchangeable potassium (0.084 me %) was recorded from T_0 treatment.

4. Conclusion

Applications of RFD+2 times spray of Flora was the superior among the other treatments in consideration of yield contributing characters and yield of BRRI Dhan BR 11 (Mukta) in transplanted aman season under the agro-climatic condition of Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka.

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