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Foliar Application of Urea and Magic Growth Liquid Fertilizer on the Yield and Nutrient Content of Aman Rice Cultivars

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Abstract: The experiment was undertaken at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the Aman season from July to December, 2013 to find out the effect of foliar application of urea along with magic growth spray on the yield and nutrient content of two Aman rice cultivars. The two factorial experiments were laid out in a RCBD design with three replications. Two rice varieties *viz.,* Bina-sail (V_1), BRRI dhan46 (V_2) and eight different nitrogen doses and application methods *i.e.* T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$ (50% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), T_5=$N_{75+10\%}$ (75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), T_6=N_{100} (100% of RD of Urea was applied as topdressing), T_7=$N_{100+10\%}$ (100% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray) were used in this experiment. BRRI dhan46 and 75% Urea top dressing and 10% Urea with magic growth as foliar spray gave the highest number of effective tillers hill^{-1}, longer panicle, number of total grains panicle^{-1}, 1000-grain weight, grain yield, straw yield and N, P, K content in rice grain. Moreover, 75% Urea top dressing and 10% Urea of the recommended dose with magic growth as foliar spray increased 8.27% grain yield with a saving of 15% of the recommended nitrogen fertilizer compared to recommended practice.

Key words: Foliar spray · Rice · Top dressing · Urea · Yield

INTRODUCTION

Rice is the most important human food, eaten by more than half of the world's population every day. In Asia, where 90% of rice is consumed, ensuring there is enough affordable rice for everyone, or rice security, is equivalent to food security [1]. It is the grain with the second-highest worldwide production, after corn. Bangladesh is the fourth highest rice (*Oryza sativa* L.) producing country in the world [2]. Rice is the staple dietary item for the people and per capita rice consumption is about 166 kg/year [3]. Rice alone provides 76% of the calorie intake and 66% of total protein requirement [4]. It employs about 43.6% of total labor forces [3, 5]. Rice covers about 81% of the total cropped area [3]. Rice alone shares about 96% of the total cereal food supply. Rice is grown in three seasons namely Aus (mid March to mid August), Aman (mid June to November) and Boro (Mid December to mid June). The largest part of the total production of rice comes from Aman rice. T. aman (Transplanted Aman) rice covers about 50.92% of the rice areas of Bangladesh of which modern T. aman varieties covers 60% [6]. Variety itself is a genetic factor which contributes a lot in producing yield and yield components of a particular crop. Yield components are directly related to the variety and neighboring environments in which it grows. In the year 2010 among the *aman* rice varieties modern varieties covered 69.15% and yield was 2.4 t ha^{-1} on the other hand local varieties covered 31.91% and yield was 1.37 t ha^{-1} [7]. It was the farmers who have gradually replaced the local indigenous low yielding rice varieties by HYV of rice developed by BRRI only because of getting 20% to 30 % more yield unit^{-1} land area [8].

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Nitrogen plays a key role in rice production and it is required in large amount. Nitrogen is the most important limiting nutrient in rice production and has heavy system losses when applied as inorganic sources in puddle field [9]. Nitrogen has a positive influence on the production of effective tiller per plant, yield and yield attributes [10, 11]. It is necessary to find out the suitable rate of nitrogen fertilizer for efficient management and better yield of rice. A suitable combination of variety and rate of nitrogen is necessary for better yield [11]. Rice plant cannot produce higher grain yield without addition of fertilizer in the crop field [12]. Among the nutrients, nitrogen is the kingpin in rice farming [13] for crop growth and development [14]. Nitrogen is an essential constituent of chlorophyll and well-supplied nitrogen which enhanced crop growth vigorously [15]. On the contrary, nitrogen deficiency results reduced tillering, grains panicle^{-1} and ultimately decreases grain yield of rice [16]. However, only optimum dose of N applied can play a vital role on the growth and development of rice plant [17]. N use efficiency in the wetland rice culture is very low, rarely exceeding 30-40 % [18] and more than 50 % of the applied nitrogen is lost through denitrification, volatilization, leaching and runoff [19] and ultimately affect on cash loss of farmers and sometimes causes environmental as well as ground water pollution [20, 21]. High price of urea fertilizer and its availability at the right time jeopardize rice production occasionally [22]. So, it is necessary to improve the efficiency of applied nitrogenous fertilizer utilization by rice plant [23]. All the factors provide an indication of searching an effective alternate N application method for rice cultivation [12]. However, foliar application can improve nutrient utilization and lower environment pollution through reducing amount of fertilizers added to soil [24]. In many cases aerial spray of nutrients is preferred and gives quicker and better results than the soil application [25] which minimizes N losses to the environment without affecting rice yield [26]. Most plants absorb foliar applied urea rapidly and hydrolyze the urea in the cytosol [27]. The NH_3 released may be transported into the chloroplast and be assimilated by the chloroplastidic Glutamine synthetase [28].

Recently foliar application of nutrients has become an important practice in the production of crops while application of fertilizers to the soil remains the basic method of feeding the majority of the crop plants [13]. Foliar application is well recognized and is being practiced in agriculturally advanced countries. In many cases aerial spray of nutrients is preferred and gives quicker and better results than the soil application [25]. Foliar feeding is an effective method for overcoming the flooded soil special condition. In case of foliar feeding, nutrients are absorbed directly where they are needed, the rate of the photosynthesis in the leaves is increased, nutrient absorption by plant roots is stimulated and foliar nutrition applied at critical times. Other advantages are low application rates, uniform distribution of fertilizer, reduction in plant stress, plant's natural defense mechanisms to resist plant disease and insect infestations, improvement of plant health and yield [29]. Nitrogen fertilizer is more urgent for security rice production. Liquid fertilization might reduce the use of chemical fertilizer specially the nitrogenous fertilizer in soil. In this aspect, the present study was undertaken to find out the effect of foliar spray of urea with magic growth on performance of BRRI dhan46 and Bina-sail and to calculate how much urea can be saved by using liquid fertilization of Magic Growth without the reduction of grain yield.

MATERIALS AND METHODS

Experimental Site and Climate: The experiment was carried out at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh which located at $90^0$22' E longitude and $23_0$4l' N latitude at an altitude of 8.6 meters above the sea level under the agro-ecological zone of Modhupur Tract, AEZ-28 during Kharif 2 season, July 2013 to December 2013 to find out the response of foliar application of urea along with magic growth spray on the yield parameters and nutrient content of Aman rice cultivars.

Experimental Material and Design: Rice variety Bina-sail and BRRI dhan 46 were taken as test crop for this experiment. Both the varieties are Transplanted Late Aman in type. Seeds of Bina-sail were collected from BINA (Bangladesh Institute of Nuclear Agriculture), Mymensingh and Seeds of BRRI dhan46 were collected from BRRI (Bangladesh Rice Research Institute), Gazipur. The experiment was laid out in two factors randomized complete block design with three replications. Factor A: two varieties [V_1-Bina-sail, V_2-BRRI dhan46] and factor B: different nitrogen doses and application methods [T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$ (50% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), T_5=$N_{75+10\%}$ (75% Urea was applied as top dressing and 10% Urea was applied with

magic growth as foliar spray), T_6=N_{100} (100% of RD of Urea applied as topdressing), T_7=$N_{100+10\%}$ (100% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray)]. The total numbers of unit plots were 48. The plot size was 3.0 m x 2.0 m. The distances between plot to plot and block to block were 0.5 m and 0.5 m, respectively.

Land Preparation and Fertilizer Application: The land was ploughed with a rotary plough and power tiller for four times. Ploughed soil was then brought into desirable fine tilth and leveled by laddering. The weeds were clean properly. Whole experimental land was divided into sub plots. Finally basal doses of phosphorus, potassium and sulphur fertilizers were applied in sub plots and the plots were made ready by thorough spading and leveling before transplantation. Doses of nitrogen were applied as per treatments. Magic Growth is a liquid fertilizer invented by Md. Arif Hossain Khan, Joint Director (Seed Marketing), Bangladesh Agricultural Development Corporation (BADC) which is ready for government recognition and it contains 10.51% total nitrogen, 5.58% phosphorous, 6.33% potassium, 0.10% sulphur, 0.16% zinc, 0.04% copper, 0.0006% iron, 0.006% manganese, 0.25% boron, 0.07% calcium and 0.007% magnesium, pH = 1.0.

Statistical Analysis: The data obtained from the experiment were subjected to statistical analysis following analysis of variance (ANOVA) technique [30]. The mean differences among the treatments were compared by Least Significant Difference (LSD) test at 0.05 level of probability.

RESULTS AND DISCUSSION

Number of Effective Tillers: Variety and nitrogen fertilizer doses and application methods showed significant variation on the number of effective tillers hill^{-1} of rice (Table 1). The highest number of effective tillers hill^{-1} (15.40) was observed from the V_1T_5 treatment which was statistically similar with V_1T_7 (14.90) whereas, the lowest (9.633) was observed from V_2T_0 treatment which was statistically similar with V_2T_1 (10.47), V_2T_2 (10.53), V_2T_3 (10.37) and V_2T_4(10.57). Number of effective tillers hill^{-1}can vary from cultivar to cultivar. When 75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray then it may triggered the nutrient use efficiency and thus effective tiller became higher than other application methods. Parvin *et al.* [31] conducted an experiment to investigate the effect of foliar application of urea on BRRI dhan 29 and found that yield and yield

Table 1: Effect of variety and different doses of nitrogen and application methods on number of effective tillers hill^{-1}, panicle length and total number of grains panicle^{-1}.

Treatments				
Variety	Nitrogen doses	Number effective tillers hill^{-1}	Panicle length (cm)	Total number of grains panicle $^{-1}$
V_1	T_0	11.97 e	22.80 b	107.6 h
	T_1	12.20 c-e	23.37 b	109.5 h
	T_2	12.40 c-e	23.44 b	108.6 h
	T_3	13.00 b-d	23.47 b	118.4 g
	T_4	13.13 bc	23.73 ab	129.1 de
	T_5	15.40 a	25.80 a	130.1 cd
	T_6	13.60 b	24.53 ab	118.0 g
	T_7	14.90 a	24.87 ab	117.6 g
V_2	T_0	9.633 f	22.84 b	109.1 h
	T_1	10.47 f	23.10 b	108.0 h
	T_2	10.53 f	23.64 ab	125.3 ef
	T_3	10.37 f	24.30 ab	123.6 f
	T_4	10.57 f	24.59 ab	129.1 de
	T_5	13.47 b	25.90 a	152.1 a
	T_6	12.03 de	24.70 ab	134.2 c
	T_7	12.80 b-e	24.87 ab	142.1 b
$LSD_{(0.05)}$		0.9963	2.275	4.360
CV (%)		4.86	10.609	9.22

Means with different letters in the same row indicate significant differences according to the LSD test.

V_1= Bina-sail, V_2=BRRI dhan46. T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray), T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing), T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Table 2: Effect of variety and different doses of nitrogen and application methods on 1000 grain weight, grain yield and straw yield

Treatments				
Variety	Nitrogen doses	1000 grains weight (g)	Grain yield (t ha $^{-1}$)	Straw yield (t ha $^{-1}$)
V_1	T_0	17.57 c	3.198 e	4.121 h
	T_1	16.70 c	3.743 c-e	5.100 d-f
	T_2	16.47 c	3.590 de	4.810 e-g
	T_3	16.00 c	3.723 c-e	4.480 gh
	T_4	15.93 c	4.143 b-d	4.657 f-h
	T_5	17.53 c	5.220 a	6.170 ab
	T_6	15.87 c	4.110 b-d	4.900 d-g
	T_7	16.37 c	4.393 b	5.097 d-f
V_2	T_0	24.50 ab	4.327 bc	4.667 f-h
	T_1	25.77 ab	4.487 b	5.427 cd
	T_2	25.17 ab	4.600 b	6.460 a
	T_3	24.10 b	5.273 a	6.130 ab
	T_4	25.60 ab	5.277 a	5.280 c-e
	T_5	26.17 a	5.610 a	6.500 a
	T_6	24.80 ab	5.320 a	5.750 bc
	T_7	25.37 ab	5.350 a	6.240 ab
$LSD_{(0.05)}$		1.837	0.5760	0.5220
CV (%)		5.28	15.24	19.12

Means with different letters in the same row indicate significant differences according to the LSD test.

V_1= Bina-sail, V_2=BRRI dhan46. T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray), T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing), T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

Table 3: Effect of variety and different doses of nitrogen fertilizer and application methods on N, P and K content in grain

Treatments				
Variety	Nitrogen doses	N concentration in grain (%)	P concentration in grain (%)	K concentration in grain (%)
V_1	T_0	1.093 g	0.1800 g	0.2371 i
	T_1	1.170 f	0.2215 f	0.2500 g-i
	T_2	1.285 e	0.2207 f	0.2500 g-i
	T_3	1.358 d	0.2537 e	0.2633 f-h
	T_4	1.376 d	0.2733 de	0.3600 d
	T_5	1.505 ab	0.3103 b	0.5000 a
	T_6	1.458 bc	0.2883 cd	0.4500 b
	T_7	1.450 bc	0.2050 f	0.4033 c
V_2	T_0	1.099 g	0.2050 f	0.2400 hi
	T_1	1.154 fg	0.2111 f	0.2800 f
	T_2	1.166 f	0.2183 f	0.3200 e
	T_3	1.190 f	0.2027 f	0.2728 fg
	T_4	1.287 e	0.2883 cd	0.4367 b
	T_5	1.543 a	0.3320 a	0.4900 a
	T_6	1.493 ab	0.3020 bc	0.4467 b
	T_7	1.392 cd	0.2837 cd	0.3600 d
$LSD_{(0.05)}$		0.06403	0.02025	0.02365
CV (%)		2.35	2.65	2.57

Means with different letters in the same row indicate significant differences according to the LSD test.

V_1= Bina-sail, V_2=BRRI dhan46. T_0=N_0 (No nitrogen applied), T_1=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), T_2=$N_{50+5\%}$(50% Urea of the RD was applied as top dressing and 5%Urea of the RD was applied with magic growth as foliar spray), T_3=$N_{50+10\%}$ (50% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_4=$N_{75+5\%}$ (75% Urea as top dressing and 5% Urea with magic growth as foliar spray), T_5=$N_{75+10\%}$ (75% Urea as top dressing and 10% Urea with magic growth as foliar spray), T_6=N_{100} (100% Urea topdressing), T_7=$N_{100+10\%}$ (100% Urea as top dressing and 10% Urea with magic growth as foliar spray).

contributing characters (i.e. highest number of effective tillers hill^{-1}) of *Boro* rice *cv*. BRRI dhan 29 were significantly influenced by foliar application of urea.

Panicle Length: Significant influence was observed on panicle length (cm) due to the different varieties and nitrogen fertilizer doses and application methods of T. *aman* rice (Table 1). The highest length of panicle (25.90 cm) was obtained from V_2T_5 which was statistically similar with V_1T_5 (25.80 cm). In contrast the lowest number of panicle length (22.80 cm) was recorded from the treatment combination V_1T_0 which was statistically similar with V_1T_1 (23.37 cm), V_1T_2 (23.44 cm) V_1T_3 (23.47 cm), V_2T_0 (22.84 cm) and V_2T_1 (23.10 cm). It is very obvious that panicle length can vary from variety to variety. Topdressing of urea along with foliar spray gave better results. Ndaeyo *et al.* [32] conducted an experiment in Nigeria with five rice varieties and found that higher N doses increased length of central panicle per plant.

Total Number of Grains: Variety and nitrogen fertilizer doses and application methods showed significant variation on total number of grains panicle^{-1} of T. *aman* rice (Table 1). The highest total number of grains panicle^{-1} (152.1) was observed from the V_2T_5 treatment and the lowest (107.6) was observed from V_1T_0 treatment which was statistically similar with V_1T_2 (109.5) and V_1T_4 (108.0). Rahman *et al.* [33] conducted an experiment where the results showed that Nitrogen level significantly influenced growth and yield components and maximum grains/panicle was found from 80 kg N/ha.

1000-grain Weight: 1000-grain weight of Aman rice significantly influenced by the effect of variety and nitrogen fertilizer doses and application methods (Table 2). The highest 1000-grain weight (26.17 g) was recorded from V_2T_5 treatment. On the other hand, V_1T_6 showed the lowest result (15.87 g) which was statistically similar with V_1T_0 (17.57 g), V_1T_1 (16.70 g), V_1T_2 (16.47), V_1T_3 (16.00), V_1T_4 (15.93 g), V_1T_5 (17.53 g) and V_1T_7 (16.37 g). Azam *et al.* [34] conducted an experiment to find out the influence of variety and different urea fertilizer application method on growth and yield of *boro* rice and result showed that variety and urea fertilizer application method had significant effect on 1000 grains weight.

Grain Yield: Variety and nitrogen fertilizers doses and application methods have significant effect on grain yield of rice (Table 2). The highest grain yield (5.610 t ha^{-1}) was obtained from V_2T_5 treatment which was statistically similar with V_1T_5 (5.220 t ha^{-1}), V_1T_6 (5.273 t ha^{-1}), V_2T_4 (5.277 t ha^{-1}), V_2T_6 (5.320 t ha^{-1}) and V_2T_7 (5.350 t ha^{-1}). On the other hand V_1T_0 showed the lowest result (3.198 t ha^{-1}) which was statistically similar with V_1T_1 (3.743 t ha^{-1}), V_1T_2 (3.590 t ha^{-1}) and V_1T_3 (3.723 t ha^{-1}). Alam *et al.* [35] observed that, liquid fertilization with Magic Growth along with 75% of the recommended nitrogen fertilizer increased 10.5% grain yield with a saving of 25% of the recommended nitrogen fertilizer compared to recommended practice. Shafiee *et al.* [36] conducted an experiment using liquid fertilizer SBAJATM (formerly known as BIPOMIXTM) and found the highest yield of grains (9.66 tons ha^{-1}) compared with (7.49 tons ha^{-1}) in the control plots. Islam *et al.* [37] observed that grain yield influenced significantly due to application of different rates of nutrients and 60-19-36 kg/ha NPK maximized the yield of T. *aman* rice varieties in respect of yield and economics.

Straw Yield: Variety and nitrogen fertilizer doses and application methods have significant effect on straw yield of rice (Table 2). The highest straw yield (6.500 t ha^{-1}) was obtained from V_2T_5 treatment which was statistically similar with V_2T_2 (6.460 t ha^{-1}). On the other hand, V_1T_0 showed the lowest result (4.121 t ha^{-1}) treatment. Ndaeyo *et al.* [32] conducted an experiment in Nigeria with five rice varieties where they found that higher rates of NPK resulted in higher straw yield of rice. Azam *et al.* [34] conducted an experiment to find out the influence of variety and different urea fertilizer application method on growth and yield of *boro* rice and result showed that variety and urea fertilizer application method had significant effect on straw yield.

Chemical Composition: N, P and K Content in Grain: N content in grain varied significantly due to the effect of variety and nitrogen fertilizer doses and application methods (Table 3). The highest N content in grain (1.543%) was observed from V_2T_5 which is statistically similar with V_1T_5 (1.505%) and V_2T_6 (1.493%), while the lowest content (1.093%) was recorded from V_1T_0 which is statistically similar with V_2T_0 (1.099%).

From Table 3, it is clear that the effect of variety and nitrogen fertilizer doses and application methods have significant effect on P content in grain. The highest P content in grain (0.3320%) was observed from V_2T_5 while the lowest result (0.1800%) was recorded from V_1T_0.

K content in grain varied significantly due to the effect of variety and nitrogen fertilizer doses and application methods (Table 3). The highest K content in

grain (0.5000%) was observed from V_2T_5 which is statistically similar with V_1T_5 (0.4900%), while the lowest content (0.2371%) was recorded from V_1T_0 treatment.

CONCLUSIONS

The yield contributing parameters, grain yield and N, P, K content in grain of Aman rice cultivars are influenced by variety and different doses of nitrogen fertilizer and application methods. Therefore, the present experimental results suggest that interaction of BRRI dhan46 and 75% Urea top dressing and 10% Urea with magic growth as foliar spray gave better result than other treatments on grain yield and N, P, K content of rice. Moreover, 75% Urea top dressing and 10% Urea of the recommended dose with magic growth as foliar spray increased 8.27% grain yield with a saving of 15% of the recommended nitrogen fertilizer compared to recommended practice.

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