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Reducing soil application of nitrogenous fertilizer as influenced by liquid fertilization on yield and yield traits of kataribhog rice

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Abstract

An experiment was set up at the research farm of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Banglaadesh during the period of August 2013 to January 2014 to find out the efficacy of liquid fertilization (Magic Growth) on the performance of Kataribhog rice and to calculate how much urea can be saved without the reduction of grain yield. The experiment was accommodated with the split plot design with two levels of liquid fertilization viz., no liquid fertilization (L_0), Liquid fertilization with Magic Growth applied at 30, 45 and 60 DAT (L_1), and four levels of nitrogen fertilizer viz., no nitrogen fertilizer (N_0), 50% recommended nitrogen fertilizer (N_{50}), 75% recommended nitrogen fertilizer (N_{75}) and 100% recommended fertilizer (N_{100}). The liquid fertilizer and nitrogen fertilizer doses were assigned to the main plot and sub-plot, respectively. Liquid fertilization (L_1) treatment provided greater grain yield compared to no liquid fertilization treatment (L_0) in all nitrogen levels. Furthermore, with the increment of nitrogen level the grain yield was increased up to N_{100} compared to no liquid fertilization treatment (L_0), but in the application of liquid fertilization treatment (L_1), grain yield was increased up to N_{75} and thereafter decreased in N_{100}dose application. Moreover, 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.

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Introduction

Rice (*Oryza sativa* L.) is one of the most important crops in Bangladesh and It is the largest crop in terms of area and production in Bangladesh (BBS, 2008). Although rice is consuming large acreage, Bangladesh is still far behind than other rice producing countries. There are many reasons for this low yield. The most important of them is the indiscriminate and improper application of nutrients with unfavorable condition. Many factors determine the fertilizer use efficiency for rice crop during cultivation such as soil, cultivar, season, environment, planting time, water management, weed control, cropping pattern, source, form, rate, time of application and method of application (De Datta, 1978).Rice is mainly cultivated in flooded fields. The unique properties of flooded soils make rice nutrient management different from any other crop. Submerging rice field brings a series of physical, chemical and microbial changes in the soil, which profoundly affects growth of rice plant as well as availability, loss and absorption of nutrients due to chemical reduction of soil and decrease in concentrations of water-soluble Zn and Cu (Ghildyal, 1978). Nearly 70% of the land area of the country has been brought under rice cultivation. Out of this 70%, fine rice is cultivated in roughly 10% land. This lower coverage is primarily due to the emphasis of government policy and research on food grain production but with low input technology. Nutrient management practices determine the sustainability of the most intensively cropping systems (Flinn*et al.,* 1982). Therefore, there is an imperative need to provide the required nutrients over and above the regular soil application through foliar application as well. 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 (Jamal *et al.*, 2006). 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. 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 (Finck, 1982). 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 liquid fertilization (Magic Growth) on performance of Kataribhog rice and to calculate how much urea can be saved by using liquid fertilization of Magic Growth without the reduction of grain yield.

Materials and method

The experiment was carried out at the research farm and laboratory of Crop Physiology and Ecology Department, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh during the period of August 2013 to January 2014.The experiment was laid out in a split plot design with two levels of liquid fertilization viz., no liquid fertilization (L_0), Liquid fertilization with Magic Growth applied at 30, 45 and 60 DAT (L_1), and four levels of nitrogen fertilizer viz., no nitrogen fertilizer (N_0), 50% recommended nitrogen fertilizer (N_{50}), 75% recommended nitrogen fertilizer (N_{75}) and 100% recommended fertilizer (N_{100}). The liquid fertilizer and nitrogen fertilizer doses were assigned to the main plot and sub-plot, respectively. The experimental field was associated with non-calcarious dark gray, floodplain soil under the Agro-Ecological Zone (AEZ-1) of Old Himalayan Piedmont Plain (Anonymous 1988). It wasmedium high, sandy loam soil.

Nursery bed of 3m x 1m size was prepared for seedling raising.Then after soaking in 24 hours and incubated for 48 hours, the sprouted seeds were sown in the seedbedon 31 July, 2013 to obtain 30 days old seedling at transplanting date (30 August, 2013). Afterwards total 24 (3 × 2 × 4) number of plots was prepared by keeping unit plot size 25 m² (5m x 5m) and also having a plot to plot and block to block distance of 1 m and 1.5 m, respectively.

Fertilizer was applied at the rate of 120-100-60-15-5 kg ha^{-1} Urea, Triple Supper Phosphate (TSP), Muriate of Potash (MoP), Gypsum and Zinc Sulphate, respectively as recommended dose for Aman rice. After land preparation, cowdung and full doses of triple supper phosphate (TSP), murate of potash (MOP), gypsum and zinc sulphate were incorporated thoroughly into the soil as basal dose. For liquid fertilization, 32 ml Magic growth + 300 g Urea + 100 g Muriate of Potash ware dissolved in 16 liter clean water to spray 445.4 m² of land. Urea and Magic growth were applied in different plots as like (Table 1). Maintaining 20 cm line to line and hill to hill spacing, the seedlings are transplanted on main fields at 30 August, 2013. Then the necessary intercultural management practices were done as for requirements.

Plant height, tillers $hill^{-1}$ and panicle $hill^{-1}$ at harvest andSpikelets $panicle^{-1}$, grains $panicle^{-1}$ and 1000-grains weight at harvest were recorded and for recoding these data sample were selected from the central 1m² area of each unit plot. Grain and straw yield were recorded by collecting samples from an area of 5 m² of each plot. Grain yield was adjusted at 14% moisture level and straw was dried in sun.

Results and discussion

Plant height at harvest

Plant height was influenced significantly by liquid fertilization, nitrogen levels and combined effect of liquid fertilization and nitrogen levels(Table 2). Greater plant height (124.81 cm) was recorded when magic growth was applied on leaf (L_1) compared to that (120.81 cm) recorded in no liquid fertilization treatment (L_0). The tallest plant (125.55 cm) was observed when recommended nitrogen fertilizer was applied as urea (N_{100}) which was statistically equal to that recorded from N_{75} (125.58 cm). The combined effect of liquid fertilization and nitrogen levels also influenced the plant height significantly. The tallest plant (128.40 cm) was observed in L_1N_{75}which was statistically similar to that recorded from L_1N_{100} (127.31 cm). The shortest plant (117.36 cm) was recorded in L_0N_0 treatmentand followed by L_0N_{50} treatment (119.33 cm). Chopra and Chopra (2004) reported that nitrogen had significantly effects on yield attributes such as plant height, panicle $plant^{-1}$ and 1000-seed weight with increasing levels of N up to 120 kg N ha^{-1} in rice.

Table 1. Application schedule of Urea and liquid fertilizer (**Magic growth) in different plots.

Treatment	At 7 DAT	At 30 DAT	At 45 DAT	At 60 DAT
L_0N_0	-	-	-	-
L_0N_{50}	33.33% Urea	16.67% Urea	-	-
L_0N_{75}	25.00% Urea	25.00% Urea	25.00% Urea	-
L_0N_{100}	33.33% Urea	33.33% Urea	33.33% Urea	-
L_1 N_0	-	LF	LF	LF
L_1 N_{50}	33.33% Urea	16.67% Urea+ LF	LF	LF
L_1 N_{75}	25.00% Urea	25.00% Urea + LF	25.00% Urea + LF	LF
L_1 N_{100}	33.33% Urea	33.33% Urea + LF	33.33% Urea + LF	LF

LF indicates liquid fertilization with Magic Growth.

% Urea indicates percent of recommended dose of urea.

**Magic Growth is a liquid fertilizer invented by Md. ArifHossain 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.

Panicle length

Panicle length was influenced significantly by both nitrogen levels and liquid fertilization(Table 2). Greater panicle length (20.94 cm) was recorded when magic growth was applied on leaf (L_1) compared to that (20.57 cm) recorded in no liquid fertilization treatment (L_0).The longest panicle (21.68 cm) was observed when recommended nitrogen fertilizer was applied as urea (N_{100}) which was statistically similar to those (21.12 cm, 20.27 cm) recorded from N_{75} and N_{50} respectively. The shortest panicle (13.22 cm) was recorded in N_0 treatment. The combined effect of liquid fertilization and nitrogen levels did not influence the length of panicle significantly and it ranged from 19.87 cmin L_0N_0 to 22.07 cm in L_1N_{100}.

Table 2. Effect of liquid fertilization and nitrogen levels on plant height, panicle length, tillers hill^{-1} and effective tiller hill^{-1} of Kataribhog rice at harvest.

Treatment	Plant height (cm)	Panicle length (cm)	Tillers hill^{-1}	Panicle hill^{-1}
L_0	120.81 b	20.57 b	15.58 b	12.59 b
L_1	124.81 a	20.94 a	16.44 a	13.93 a
Level of significance	*	**	**	*
N_0	118.60 b	13.22 b	14.80 a	12.53 a
N_{50}	121.51 ab	20.278 ab	15.51 a	13.13 a
N_{75}	125.58 a	21.12 ab	16.41 a	13.72 a
N_{100}	125.55 a	21.68 a	16.55 a	13.66 a
Level of significance	**	**	NS	NS
L_0N_0	117.36 e	19.87	13.73	11.72 c
L_0N_{50}	119.33 de	20.50	14.67	12.57 bc
L_0N_{75}	122.76 cd	20.60	15.73	12.85 bc
L_0N_{100}	123.78 bc	21.30	16.60	13.22 abc
L_1N_0	119.84 cde	19.97	15.87	13.33 abc
L_1N_{50}	123.69 bc	20.07	16.35	13.68 ab
L_1N_{75}	128.40 a	21.64	17.08	14.60 a
L_1N_{100}	127.31 ab	22.07	16.45	14.10 ab
Level of significance	**	NS	NS	**
CV (%)	1.23	2.18	6.07	4.47

Means followed by different letter(s) at specific days after transplanting in a column within the main effects and the interaction effect differed significantly by DMRT at $P \leq 5\%$.

Tillers hill^{-1} at harvest

Number of tillers hill^{-1}was influenced significantly by liquid fertilization and nitrogen levels (Table 2). Higher tillers hill^{-1} (16.44) was recorded when Magic Growth was applied on leaf (L_1) compared to that (15.58) recorded in no liquid fertilization treatment (L_0). With the increment of nitrogen level tillers hill^{-1} was not increased significantly and it ranged from 14.80 to 16.55 within the various treatments. The combined effect of liquid fertilization and nitrogen levels did not influence the number of tillers hill^{-1}significantly and it ranged from 13.73 to 17.08 among the treatments. (Shariefet *al.* 2006) found that increasing nitrogen fertilizer levels had significant effect on plant height, tillers hill^{-1} and leaves hill^{-1}.

Panicle hill^{-1}

Liquid fertilization, nitrogen levels and the combined effect of liquid fertilization and nitrogen levels showed significant influence on the number of panicle hill^{-1} but the levels of nitrogen did not influenced significantly on panicle hill^{-1}(Table 2). The number of panicle hill^{-1} was increased in liquid fertilization treatment (L_1) compared to that no liquid fertilization treatment (L_0).The treatment combinations, L_1N_{75} provided the highest number of panicle hill^{-1} (14.60) which was statistically at par with those provided by L_1N_{100} (14.10) and L_1N_{50} (13.68). L_0N_0 provided the lowest number of panicle hill^{-1} (11.72) which was similar to those provided by L_0N_{50} (12.57) and L_0 N_{75} (12.85) The other treatment combination L_0N_{100} and L_1N_0 provided the statistically equal number of panicle hill^{-1} (13.22) and (13.33) respectively. This result is closely similar with the result of Pramanik (2013) in BRRIdhan 28.

Table 3. Effect of liquid fertilization and nitrogen levels on spikelets panicle^{-1}, grains panicle^{-1} and 1000-grains weight of Kataribhog rice at harvest.

Treatment	Spikelets panicle^{-1}	Grains panicle^{-1}	1000-grains weight	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
L_0	120.59	96.66 b	12.10 b	2.23	3.84
L_1	122.95	103.93 a	12.88 a	2.27	4.38
Level of significance	NS	**	**	NS	NS
N_0	108.67 c	91.27 b	11.50 b	1.93 b	3.55 b
N_{50}	114.98 c	95.52 b	12.49 ab	2.30 a	4.14 ab
N_{75}	126.38 b	106.47 a	12.95 a	2.48 a	4.24 ab
N_{100}	137.10 a	107.92 a	12.98 a	2.46 a	4.50 a
Level of significance	**	**	**	**	**
L_0N_0	107.65	89.00 e	11.25	1.84 c	3.56 b
L_0N_{50}	113.51	91.40 e	12.21	2.28 b	3.65 b
L_0N_{75}	124.36	98.42 cd	12.15	2.38 ab	3.75 b
L_0N_{100}	136.85	107.81 b	12.64	2.40 ab	4.40 a
L_1N_0	109.69	93.53 de	11.75	2.02 c	3.53 b
L_1N_{50}	116.45	99.64 c	12.76	2.32 b	4.62 a
L_1N_{75}	128.39	114.52 a	13.67	2.58 a	4.74 a
L_1N_{100}	137.29	108.03 b	13.31	2.54 ab	4.60 a
Level of significance	NS	**	NS	**	**
CV (%)	1.85	2.15	2.65	4.14	5.56

Means followed by different letter(s) at specific days after transplanting in a column within the main effects and the interaction effect differed significantly by DMRT at $P \le 5\%$.

Spikelets panicle^{-1}

Number of spikelets panicle^{-1} was not influenced significantly by liquid fertilization but influenced significantly by nitrogen levels (Table 3). With the increment of nitrogen level number of spiklets panicle^{-1} was increased. The highest number of spiklets panicle^{-1} (137.10) was observed when recommended nitrogen fertilizer was applied as urea (N_{100}). The lowest number of spiklets panicle^{-1} (108.67) was recorded in N_0 treatment which was statistically equal to those recorded from N_{50} (114.98). The other treatment combination N_{75} performs moderately.The combined effect of liquid fertilization and nitrogen levels did not influence the number of spiklets panicle^{-1} significantly and it ranged from 107.65 in L_0N_0 to 137.29 in L_1N_{100}.

Grains panicle^{-1}

Number of grains panicle^{-1} was influenced significantly by liquid fertilization, nitrogen levels and the combined effect of liquid fertilization and nitrogen levels (Table 3). The number of grains panicle^{-1} was increased in liquid fertilization treatment (L_1) compared to that no liquid fertilization treatment (L_0). The highest number of grains panicle^{-1} (107.92) recorded from N_{100} which was statistically equal to that (106.47) obtained from N_{75}.Among the treatment combinations, L_1N_{75} provided the highest number of grains panicle^{-1} (114.52). Lin and Zhu (2000) found that foliar spray of fertilizer at heading stage increased grain yield as a result of increasing grain number per panicle.

1000-grains weight

1000-grain weight of Kataribhog rice was influenced significantly by liquid fertilization and nitrogen levels (Table 3). 1000-grain weight was increased in liquid fertilization treatment (L_1) compared to that no liquid fertilization treatment (L_0). The highest 1000-grain weight (12.98) was recorded in N_{100} which was statistically equal to that (12.95) obtained from N_{75}. The lowest 1000-grain weight (11.50) was recorded in N_0 which was statistically similar to that (12.49) obtained from N_{50}. Soylu*et al.* (2005) reported a significant increase in 1000 grain weight with the foliar application of micronutrients.

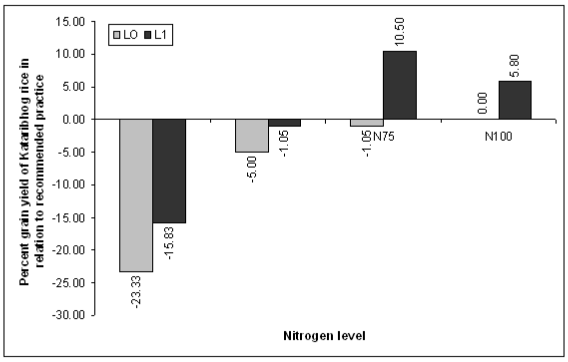

Fig. 1. Percent grain yield of Kataribhog in relation to recommended practice as influenced by liquid fertilization and nitrogen levels. *(*Here, L_0 = No liquid fertilization, L_1 = liquid fertilization with Magic Growth, N_0 = No nitrogen fertilizer, N_{50} = 50% of the recommended nitrogen fertilizer, N_{75} = 75% of the recommended nitrogen fertilizer and N_{100} = 100% of the recommended nitrogen fertilizer*)*.

Grain yield

In general, liquid fertilization (L_1) treatment provided greater grain yield compared to no liquid fertilization treatment (L_0) (Table 3). Grain yield was increased with the increment of nitrogen level up to N_{75} and thereafter decreased in N_{100}. The highest grain yield (2.48 t ha^{-1}) was recorded in N_{75} which was statistically equal to N_{100} andN_{50} (2.46 and 2.30 t ha^{-1}, respectively). Among the treatment combinations, L_1N_{75} provided the highest grain yield (2.58 t ha^{-1}) which was statistically similar to that provided by L_1N_{100} (2.54 t ha^{-1}), L_0N_{100} (2.40 t ha^{-1}) and L_0N_{75} (2.38 t ha^{-1}). L_0N_0 provided statistically the lowest grain yield (1.84 t ha^{-1}) which was statistically equal to that provided by L_1N_0 (2.02 t ha^{-1}).

The results presented in (Figure 1) revealed that liquid fertilization with magic growth along with 50% of the recommended nitrogen fertilizer i.e., L_1N_{50} provided only 1.05% lesser grain yield provided by recommended nitrogen fertilizer treatment only (L_0N_{100}). L_1N_{75} treatment combination can increased 10.50% grain yield compared to recommended practice (L_0N_{100}) with a saving of 25% of the recommended nitrogen fertilizer per hectare of land. Liquid fertilization along with recommended nitrogen fertilizer (L_1N_{100}) can increased 5.80% grain yield compared to recommended practice. It has been reported that a small amount of nutrients (nitrogen, potash or phosphate) by foliar spraying increases yield of crops (Asenjo*et al.*, 2000).The results of the present study indicated that liquid fertilization significantly affected effective tillers hill^{-1}, grains panicle^{-1}, thousand grains weight grain yield and straw yield of Kataribhog rice. These results are in good accordance with those reported by Shafiee *et al.* (2013).

Straw yield

Straw yield was not influenced significantly by liquid fertilization but influenced significantly by nitrogen levels and the interaction effect of liquid fertilization and nitrogen levels (Table 3). The highest straw yield (4.38 t ha^{-1}) was obtained in liquid fertilization treatment (L_1) compared to that no liquid fertilization treatment (L_0) (3.84 t ha^{-1}). The highest straw yield (4.50 t ha^{-1}) was obtained when recommended nitrogen fertilizer was applied as urea (N_{100}) which was statistically similar to those recorded in N_{75} (4.24 t ha^{-1}) and N_{50} (4.14 t ha^{-1}). Among the treatment combinations, L_1N_{75} provided the highest straw yield (4.74 t ha^{-1}) which was statistically equal to those provided by L_1N_{100} (4.60 t ha^{-1}) and L_1N_{50} (4.62 t ha^{-1}) and L_0N_{100} (4.40 t ha^{-1}) respectively.

Conclusion

The liquid fertilization (L_1) treatment provided greater grain yield compared to no liquid fertilization treatment (L_0) in all nitrogen levels. In liquid fertilization treatment (L_1), grain yield was increased up to N_{75} and thereafter decreased in N_{100}dose application.The liquid fertilization with Magic Growth along with 75% of the recommended nitrogen fertilizerincreased 10.5% grain yield with a saving of 25% of the recommended nitrogen fertilizer compared to recommended practice.

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