ISSN: 0975-833X

Available online at http://www.journalcra.com

International Journal of Current Research
Vol. 8, Issue, 04, pp.29069-29073, April, 2016

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

RESEARCH ARTICLE

GROWTH PARAMETERS OF AMAN RICE AS INFLUENCED BY THE FOLIAR APPLICATION OF UREA AND MAGIC GROWTH LIQUID FERTILIZER

[1,*]Mominul Haque Rabin, [1]Md. Abdur Razzaque, [1,*]Sheikh Shawkat Zamil, [1]Kh. Ashraf-Uz-Zaman, [2]Md. Abubakar Siddik and [2]Shahidul Islam

[1]Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh
[2]Department of Agricultural Botany, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh

ARTICLE INFO

Article History:
Received 21st January, 2016
Received in revised form
19th February, 2016
Accepted 02nd March, 2016
Published online 26th April, 2016

Key words:

Urea,
Magic Growth,
Foliar,
Top Dressing,
Growth.

ABSTRACT

An experiment was conducted at the farm of Sher-e-Bangla Agricultural University, Dhaka-1207 during the Aman season from July to December, 2013 to find out the influence of foliar application of urea along with magic growth spray on the growth parameters of Aman rice. The one factorial experiment was laid out in a RCBD design with three replications. The treatments were : 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 N applied as Urea 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 75% Urea top dressing and 10% Urea with magic growth as foliar application gave higher results in most of the growth parameters. In case of plant height, number of tillers, number of leaves, effective tillers hill^{-1} results were maximum and minimum in non-effective tillers hill^{-1} with75% Urea top dressing and 10% Urea with magic growth as foliar spray. Moreover, 75% Urea top dressing and 10% Urea of the recommended dose with magic growth as foliar spray increased all the growth attributes with a saving of 15% of the recommended nitrogen fertilizer compared to recommended practice.

Citation: Mominul Haque Rabin, Md. Abdur Razzaque, Sheikh Shawkat Zamil, Kh. Ashraf-Uz-Zaman, Md. Abubakar Siddik and Shahidul Islam, 2016. Growth parameters of aman rice as influenced by the foliar application of urea and magic growth liquid fertilizer", *International Journal of Current Research*, 8, (04), 29069-29073.

INTRODUCTION

Rice (Oryza sativa L.) belongs to the cereal crops under Gramineae family. It is one of the world's most widely consumed grains which play a unique role in combating global hunger. Rice is intensively cultivated in Bangladesh covering about 80% of arable land. As staple food rice alone constitutes 95% of the food grain production in Bangladesh. Unfortunately, the yield of rice is low in Bangladesh as compared to that of other rice growing countries like South Korea and Japan where the average yield is 7.00 and 6.22 t/ha, respectively (FAO, 1999).

Corresponding author: **Sheikh Shawkat Zamil,**
Department of Agricultural Chemistry, Sher-e-Bangla Agricultural University, Dhaka, Bangladesh.

Bangladesh is an agro-based country with population of about 160 millions living in 14.84 million hectares of land and according to the estimate of World Bank, the population will have possibly increased to 230 million by the year 2030 (BBS, 2010). Rice alone provides 76% of the calorie intake and 66% of total protein requirement (Bhuiyan *et al.,* 2002). Rice is the staple dietary item for the people and per capita consumption 166 kg/year, which covers about 81% of the total cropped area and employs about 43.6% of total labor forces (BBS, 2010). Rice alone shares about 96% of the total cereal food and 9.5 % of the total agricultural GDP in the country. Among all crops, rice is the driving force of Bangladesh agriculture (MoFDM, 2012).On the other hand, the demand for increasing rice production is mounting up to feed the ever-increasing population of this country. 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% (BBS, 2005). In Bangladesh total cultivable land is 10 million hectare and near about 70 per cent of this land is occupied by rice cultivation. In the year 2011, the total production of rice was 33.5 million metric ton.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} (BBS, 2011).

Nitrogen plays a key role and the most important limiting nutrient in rice production and it is required in large amount. Nitrogen has a positive influence on the production of effective tiller per plant, yield and yield attributes (Jashim *et al.,* 1984, BRRI, 1990). Among the nutrients, nitrogen is the kingpin in rice farming (Alam *et al*., 2012) for crop growth and development. Nitrogen is an essential constituent of chlorophyll and well-supplied nitrogen which enhanced crop growth vigorously (Dobermann and Fairhurst, 2000). On the contrary, nitrogen deficiency results reduced tillering (Peng *et al.*, 2003). However, only optimum dose of N applied can play a vital role on the growth and development of rice plant (Hasanuzzaman *et al*., 2009). The absorption patterns of applied nitrogen vary with growth stages. About 52 to 60 % of total plant nitrogen in the high yielding plants has been absorbed by early panicle formation stage (De Datta, 1981). Generally, the nitrogenous fertilizer (urea) is applied as basal and as top dressed at different growth stages for rice cultivation (BRRI, 2011). Unfortunately, N use efficiency in the wetland rice culture is very low, rarely exceeding 30-40 % and more than 50 % of the applied nitrogen is lost through denitrification, volatilization, leaching and runoff (Khan *et al*., 2009). High price of urea fertilizer and its availability at the right time jeopardize rice production occasionally, so it is necessary to improve the efficiency of applied nitrogenous fertilizer utilization by rice plant. However, foliar application can improve nutrient utilization and lower environment pollution through reducing amount of fertilizers added to soil (Abou-EI-Nour, 2002). In many cases aerial spray of nutrients is preferred and give quicker and better results than the soil application, which minimizes N losses (Jamal *et al.,* 2006). Most plants absorb foliar applied urea rapidly and hydrolyze the urea in the cytosol (Nicoulaud and Bloom, 1996). 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 (Alam *et al.,* 2012).

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 Aman 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 METHODS

The experiment was conducted at Sher-e-Bangla Agricultural University Farm, Dhaka-1207, Bangladesh which located at $90^0 22'$ E longitude and 23°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 examine the response of foliar application of urea along with magic growth spray on the growth parameters of Aman rice. A high yielding variety seed of Aman rice was collected from the Bangladesh Rice Research Institute (BRRI), Joydebpur, Gazipur. Before sowing of the seed in the experimental plot, germination test was done in the laboratory and results of percentage of germination were over 90%. The experiment was laid out in single factors randomized complete block design with three replications.

Treatments of the experiment was eight doses of N *viz.* $\mathbf{T_0}$=N_0 (No nitrogen applied), $\mathbf{T_1}$=$N_{00+10\%}$ (Urea was applied only 10% of the recommended dose (RD) with magic growth as foliar spray), $\mathbf{T_2}$=$N_{50+5\%}$ (50% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), $\mathbf{T_3}$=$N_{50+10\%}$ (50% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), $\mathbf{T_4}$=$N_{75+5\%}$ (75% Urea was applied as top dressing and 5% Urea was applied with magic growth as foliar spray), $\mathbf{T_5}$=$N_{75+10\%}$ (75% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray), $\mathbf{T_6}$=N_{100} (100% of RD of N applied as Urea topdressing), $\mathbf{T_7}$=$N_{100+10\%}$ (100% Urea was applied as top dressing and 10% Urea was applied with magic growth as foliar spray). The total plot number was 3 x 8 = 24. The unit plot size was 3.0 m x 2.0 m = 6 m^2. The distance between blocks was 1 m and distance between plots was 0.5 m and plant spacing was 15 cm × 25 cm. 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. During plant growth stage hand weedings were done according to needs. Irrigation and drainage channels were made around the plot, water was applied keeping a standing water of about 2-3 cm during the whole growing period. As per preventive measure seed was treated with a fungicide Vitavex

200 @ 2 g kg^{-1} before showing and fungal disease, Diazinon 60 EC @ 20 mL per 10 Liter of water was applied. Previous randomly selected ten plants from each plot were selected as random and were tagged for the data collection. Some data were collected from 30, 60 and 90 days of transplanting (Plant height, number of tillers $hill^{-1}$, No. of leaves $plant^{-1}$) and some data were collected at different time. The data obtained from the experiment were subjected to statistical analysis following analysis of variance technique (Russell 1986). The mean differences were tested through, least significant difference (LSD) method.

RESULTS AND DISCUSSION

Plant Height

Nitrogen fertilizer doses and application methods had significant effect on plant height of rice at 30 DAT, 60 DAT and 90 DAT (Table 1).At 30 DAT, the highest plant height (68.77 cm) was observed from the T_5 treatment which was statistically similar with T_7 (67.47 cm) and the lowest (61.42 cm) was observed from T_0 treatment. At 60 DAT, the highest plant height (118.0 cm) was observed from the T_5 treatment which was statistically similar to T_4 (112.6 cm),T_6 (113.5 cm) andT_7 (116.4 cm) whereas, the lowest (105.9 cm) was observed from T_0 treatment. At 90 DAT, the highest plant height (126.4 cm) was observed from the T_5 treatment which was statistically similar with T_7 (124.0 cm) whereas, the lowest (113.9 cm) was observed from T_0 treatment which was statistically similar with T_1 (115.9 cm). It was observed that higher doses of nitrogen gave better plant height than those of no nitrogen or lower nitrogen. These results are similar to the findings of Ahmed *et al*. (2005) who studied the effect of nitrogen on different characteristics of transplanted local aman rice variety and found that higher N dose produced higher plant height.

Table 1. Effect of different doses of nitrogen fertilizer and application methods on plant height (cm) at different days after transplanting (mean of two varieties)

Treatments	Plant height (cm)		
	30 DAT	60 DAT	90 DAT
T_0	61.42 f	105.9 d	113.9 c
T_1	63.27 e	108.9 cd	115.9 c
T_2	64.63 de	110.5 bcd	117.8 bc
T_3	65.13 cd	111.4 bcd	117.8 bc
T_4	66.65 bc	112.6 abc	119.8 abc
T_5	68.77 a	118.0 a	126.4 a
T_6	66.83 bc	113.5 abc	118.0 bc
T_7	67.47 ab	116.4 ab	124.0 ab
$LSD_{(0.05)}$	1.792	6.220	6.681
Significant level	*	*	*
CV (%)	2.32	4.70	4.75

* Significant at 5% level

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

Number of tillers

Nitrogen doses and application methods had significant effect on number of tillers $hill^{-1}$ of rice at 30, 60 and 90 DAT (Table 2). At 30 DAT, the highest number of tillers $hill^{-1}$ (15.80) was observed from the T_5 treatment and the lowest (13.70) was observed from T_0 treatment which was statistically similar with T_1 (13.90) and T_3 (14.05).At 60 DAT, the highest number of tillers $hill^{-1}$ (18.13) was observed from the T_5 treatment which was statistically similar to T_7 (17.40) whereas, the lowest (15.67) was observed from T_0 treatment which was statistically similar to T_2 (15.95). At 90 DAT, the highest number of tillers $hill^{-1}$ (16.67) was observed from the T_5 treatment which was statistically similar to T_7 (15.88) whereas, the lowest (13.47 cm) was observed from T_0 treatment which was statistically similar with T_1 (14.08) and T_2 (14.22). Foliar application of Urea with Magic growth gave higher performances than soil application. Though 100% urea topdressing + 10% urea as foliar spray with magic growth showed detrimental effect on number of tillers $hill^{-1}$. Ndaeyo *et al.* (2008) conducted an experiment where they found that higher rates of NPK resulted higher number of tillers per plant.

Table 2. Effect of different doses of nitrogen fertilizer and application methods on number of tillers $hill^{-1}$ at different days after transplanting (mean of two varieties)

Treatments	Number of tillers $hill^{-1}$		
	30 DAT	60 DAT	90 DAT
T_0	13.70 d	15.67 d	13.47 e
T_1	13.90 cd	16.22 cd	14.08 e
T_2	14.18 bcd	15.95 d	14.22 de
T_3	14.05 cd	16.33 cd	15.00 cd
T_4	14.32 bcd	16.95 bc	15.42 bc
T_5	15.80 a	18.13 a	16.67 a
T_6	14.58 bc	16.88 bc	15.50 bc
T_7	14.97 b	17.40 ab	15.88 ab
$LSD_{(0.05)}$	0.8101	0.9011	0.8576
Significant level	*	*	*
CV (%)	4.76	4.58	4.84

* Significant at 5% level

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

Number of leaves

Nitrogen fertilizer doses and application methods showed significant effect on number of leaves $hill^{-1}$ of rice at 30, 60 and 90 DAT (Table 3). At 30 DAT, the highest number of leaves $hill^{-1}$ (49.30) was observed from the T_5 treatment and the lowest (40.20) was observed from T_0 treatment. At 60

DAT, the highest number of leaves hill^{-1} (68.05) was observed from the T_5 treatment whereas, the lowest (57.97) was observed from T_0 treatment. At 90 DAT, the highest number of leaves hill^{-1} (58.00) was observed from the T_5 treatment which was statistically similar with T_4 (54.22) whereas, the lowest (49.03) was observed from T_0 treatment. Ndaeyo *et al.* (2008) conducted an experiment where they found that higher rates of NPK resulted higher number of leaves per plant.

Table 3. Effect of different doses of nitrogen and application methods on number of leaves hill^{-1} at different days after transplanting (mean of two varieties)

Treatments	Number of leaves hill^{-1}		
	30 DAT	60 DAT	90 DAT
T_0	40.20 e	57.97 d	49.03 c
T_1	42.83 d	59.67 bcd	50.93 bc
T_2	43.47 cd	58.23 cd	50.92 bc
T_3	43.77 cd	58.43 cd	52.05 bc
T_4	44.58 bcd	61.82 bc	54.22 ab
T_5	49.30 a	68.05 a	58.00 a
T_6	45.60 bc	60.38 bcd	52.80 bc
T_7	46.43 b	62.85 b	53.55 b
LSD $_{(0.05)}$	2.172	3.771	4.203
Significant level	*	*	*
CV (%)	4.14	5.25	6.77

* Significant at 5% level

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).

Number of effective tillers

Nitrogen fertilizers doses and application methods had significant effect on the number of effective tillers hill^{-1} of rice (Table 4). The highest number of effective tillers hill^{-1} (14.43) was observed from the T_5 treatment which was statistically similar with T_7 (13.85) and the lowest (10.80) was observed from T_0 treatment. Rasheed *et al.* (2003) reported that the number of effective tillers per hill was increased when NP levels were increased.

Table 4. Effect of different doses of nitrogen and application methods on number of effective tillers hill^{-1} (mean of two varieties)

Treatments	Number of effective tillers hill^{-1}	Number of non effective tillers hill^{-1}
T_0	10.80 d	2.183 a
T_1	11.33 cd	1.908 ab
T_2	11.47 cd	1.767 bc
T_3	11.68 c	1.593 bcd
T_4	11.85 c	1.533 cd
T_5	14.43 a	0.9167 f
T_6	12.82 b	1.375 de
T_7	13.85 a	1.150 ef
LSD $_{(0.05)}$	0.7045	0.3710
Significant level	*	*
CV (%)	4.86	20.23

* Significant at 5% level

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).

Number of non-effective tillers

Number of non-effective tillers hill^{-1} was significantly varied due to nitrogen fertilizer at all growth stages (Table 4). The highest number of non-effective tillers hill^{-1} (2.183) was recorded from T_0 treatment which was statistically similar with T_1 (2.183). In contrast the lowest number of non-effective tillers hill $^{-1}$ (0.9167) was recorded from T_5 treatment which was statistically similar with T_7 (1.150).

Conclusion

Nitrogen fertilizer doses and application methods had significant effect on growth and yield of aman rice. Therefore, the present experimental results suggest that when Urea was applied as foliar spray (10% of RD along with magic growth) and top-dressing (75% of RD) then it performed better than sole top-dressing or foliar spray. Foliar spray along with top dressing though performed better, but still foliar spray can not completely replace the top dressing of urea. If 75% Urea is top-dressed and 10% of the urea is applied as foliar spray along with magic growth then at least 8.27% grain yield increased and 15% urea can be saved.

Acknowledgement

This research work was funded by CP#3645, W-2, AIF(3), HEQEP, UGC, World Bank, Dept of Agricultural Chemistry, SBAU and Mominul Haque Rabin received MS-FELLOWSHIP from the mentioned subproject. This contribution is gratefully acknowledged.

REFERENCES

Abou El-Nour, E. A. A. 2002. Can supplemented potassium foliar feeding reduce the recommended soil potassium?. *Pak. J. of Biol. Sci*., 5(3): 259-262.

Ahmed, M., Islam, M. M. and Paul, S. K. 2005. Effect of nitrogen on yield and other plant characters of local T. aman rice, var. jatai. *Res. J. Agric. & Biol. Sci.* 1(2): 158-161.

Alam, S. S., Moslehuddin, A. Z. M., Islam, M. R. and Kamal, A. M. 2012. Soil and foliar application of nitrogen for Boro rice (BRRI dhan29). *J. Bangladesh Agril. Univ*., 8(2): 199-202.

BBS (Bangladesh Bureau of Statistics). 2005. The statistical Yearbook of Bangladesh. Bangladesh Bureau of Statistics, Ministry of planning, Dhaka, Bangladesh.

BBS (Bangladesh Bureau of Statistics). 2010. Statistical Year Book of Bangladesh, Statistics Division, Ministry of

Planning, Government of the People's Republic of Bangladesh, Dhaka.

BBS (Bangladesh Bureau of Statistics). 2011. Statistical Yearbook of Bangladesh. Statistics Division, Ministry of Planning, Govt. of Peoples Republic of Bangladesh. Dhaka. Bangladesh. pp. 81-128.

Bhuiyan, N. I., Paul, D. N. R. and Jabber, M. A. 2002. Feeding the Extra Millions. In: Proceedings of the BRRI-DAE Workshop on Experiences of HYV Rice Production in Bangladesh, Bangladesh Rice Research Institute, Gazipur-1701.

BRRI (Bangladesh Rice Research Institute). 1990. Nitrogen response of promising variety. Annual Rep. Bangladesh Rice Res. Inst., Joydebpur, Gazipur, pp: 95.

BRRI (Bangladesh Rice Research Institute). 2011. BRRI Annual Report 2008-2009. Publication no.187. pp.79-83.

De Datta, S K. 1981. Principles and practices of rice production. Intl. Rice Res. Inst. Los Banos, Philippines. pp. 9, 185-186, 313-396, 535.

Dobermann, A. and Fairhurst, T. 2000. Rice; Nutrient Disorders and Nutrient Management. and book Series. pp 41-47, 155-157.

FAO (Food and Agriculture Organization) 1999. Yearbook of Production, FAO Statistics Division. 605-607.

Finck, A. 1982. Fertilizers and Fertilization.VerlagChimie GmbH, Weinheim, Germany.

Hasanuzzaman, M., Nahar, K., Alam, M. M., Hossain, M. Z. and Islam, M. R. 2009. Response of transplanted rice to different application methods of urea fertilizer. *International Journal of Sustainable Agriculture*. 1(1): 01-05.

Jamal, Z., Hamayun, M., Ahmad, N. and Chaudhary, M. F. 2006. Effect of soil and foliar application of different concentrations of NPK and foliar application of $(NH_4)_2SO_4$ on different parameters in wheat. *J. Agron*. 5(2): 251-256.

Jashim, C., Ahmed, U. and Ahmed, K.U. 1984. Response of rice varieties to applied N in saline soils. Int. Rice Res. Newsl. 9(5): 22.

Khan, P, Memon, M. Y, Imtiaz, M. and Aslam. M. 2009. Respone of wheat to foliar and soil application of urea at different growth stage. *Pak. J. Bot*. 41(3): 1197-1204.

MoFDM (Ministry of Food and Disaster Management). 2012. Monitoring Report of the National Food Policy Plan of Action and Country Investment Plan, FPMU, Food Division, MoFDM, Khadday Bhaban, Dhaka.

Ndaeyo, N. U., Iboko, K. U., Harry, G. I. and Edem, S. O. 2008. Growth and yield performances of some upland rice (*oryza sativa* l.) Cultivars as influenced by varied rates of NPK (15:15:15) fertilizer on an ultisol. *J. Trop. Agric. Food. Env. Ext.* 7(3): 249 – 255.

Nicoulaud, B. A. L. and Bloom, A. J. 1996. Absorption and assimilation of foliarly applied urea in tomato. *J. Am. Soc. Hortic. Sci*. 121: 1117.

Peng, S., Buresh, R., Huang, J., Yang, J., Wang, G., Zhong, X. and Zou, Y. 2003. Principles and practices of real time nitrogen management: a care study on irrigated rice in China. Rice Science: Innovations and Impact for Livelihood. Intl. Rice Res. Inst. Los Banos, Philippines, pp. 433.

Rasheed, M., Asif, M. and Ghafoor, A. 2003. Yield and yield attributes of fine rice BAS-385 as affected by different NP levels on farmer's field. *Pak. J. Agric. Sci.* 40: 1-2.

Russel, D. F. 1986. MSTAT-C Package Programme. Dept. of Crop and Soil Science, Michigan State University, USA.

****