J. Agrofor. Environ. 5 (2): 53-56, 2011 ISSN 1995-6983

Effect of different doses of fertilizers on yield and yield components of two varieties of *boro* rice

M. A. Salam, Fouzia Lucy[1], M.H. Kabir[2] and A.R. Khan[3]
Department of Agronomy, Bangladesh Agricultural University, Mymensingh, [1]BSFIC, Dhaka, [2] Jatiya Kabi Kazi Nazrul Islam University, Trishal, Mymensingh, and [3] Department of Agronomy and Haor Agriculture, Sylhet Agricultural University, Sylhet.

Abstract: An experiment was conducted at the Agronomy Field Laboratory of the Bangladesh Agricultural University, Mymensingh under Agro-ecological zone-9 of the Old Brahmaputra flood plain during the period from November 2009 to May 2010 with a view to studying the effect of different combinations of fertilizers on the yield and yield contributing characters of boro rice. Six combinations of fertilizers such as, control, $N_{80}P_0K_0S_0Zn_0$, $N_{80}P_{60}K_0S_0Zn_0$, $N_{80}P_{60}K_{40}S_0Zn_0$, $N_{80}P_{60}K_{40}S_{30}Zn_0$ and $N_{80}P_{60}K_{40}S_{30}Zn_5$ and two rice varieties namely, BR2 and BRRI dhan29 were included in the study. N, P_2O_5, K_2O, S and Zn were applied in the form of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate, respectively. The experiment was laid out in a randomized complete block design with three replications. The treatments $N_{80}P_{60}K_{40}S_{30}Zn_0$ and $N_{80}P_{60}K_{40}S_{30}Zn_5$ produced the highest grain (4.60 tha^{-1}) and straw (5.35 tha^{-1}) yield, the highest grain (4.27 tha^{-1}) and straw (3.72 tha^{-1}) yield were also found from BRRI dhan29 and the $N_{80}P_{60}K_{40}S_{30}Zn_0$ treatment appears to be the best among the fertilizers combinations studied for growing either of the varieties.
Key words: Fertilizer dose, yield, yield component, boro rice.

Introduction

Rice *(Oryza sativa* L.) is the staple food of the one-third of the world population including Bangladesh. Agriculture covers about 74.77% of the total cropped area of Bangladesh with the production of 31.98 millions metric ton of grains from 10.78 million hectors of land (BBS, 2005). There are three rice seasons viz. *Aus*, *Aman* and *Boro* in Bangladesh. Among these, the *Boro* rice plays vital role for food production and hence, the economy of Bangladesh. During 2005-06, *Boro* rice contributed about 52.68% of total rice production. The area of *Boro* rice coverage in the country is 4.06 million hectare (MoA, 2007).

Although the geographical situation, the climatic and edaphic conditions of Bangladesh are favourable for the year round rice cultivation, but the national average yield (2.52 t ha^{-1}) of rice is low compared to that of other rice growing countries of the world (MoA, 2007). The population of our country is increasing at an alarming rate but its cultivable land area is decreasing due to rapid urbanization and industrialization. So the horizontal expansion of the rice area in Bangladesh is not possible, therefore, the yield per unit area need to be increased to solve the food deficit prevailing in the country. This could be done in many ways of which, judicious application of fertilizers and using of appropriate variety are very important. Fertilizer being the most crucial input for increasing crop production in the shortest possible time plays a vital role to mitigate the food demand of the country. In Bangladesh, fertilizer utilization is still below the optimum level to achieve the potential yield for satisfying the countries food requirement. Among the fertilizers, nitrogen plays a key role in rice production. Nitrogen is essential for the encouragement of vegetative growth, but excess of it unnecessarily prolongs the growth duration and delays maturity by encouraging excessive vegetative growth (Brady, 1988). Phosphorus influences the flowering and ripening. Potassium influences root development, fruit development, ripening and increases disease resistance ability (Tisdale and Nelson, 1966). Sulphur and Zinc are very much beneficial for increasing the production of rice (Islam *et al.* 1987; Dutta *et al.* 1987). Sulphur deficiency delays growth and development of plant while zinc deficiency hampers chlorophyll production and protein synthesis. Moreover, the imbalance macro and micronutrients result nutritional disorder, growth retardation and reduced yield. Therefore, it is essential to use the balanced dose of fertilizers for satisfactory yield of rice.

The work on NPK with S and Zn are very few in Bangladesh. Therefore, the present study was undertaken to evaluate the effect of different doses of fertilizers on the yield and yield contributing characters of two *Boro* rice varieties BR2 and BRRI dhan29.

Materials and Methods

The experiment was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh during the period form November 2009 to May 2010. The experimental site belongs to the old Brahmaputra Flood plain (AEZ-9). Non-calcareous dark-grey and flood plain soils are generally predominate in the site. The land was medium high and the soil was silty-loam and well drained and its general fertility level was low. The soil of the experimental field was more or less neutral in reaction, low in organic matter content. The experiment consist six types of fertilizer dose viz. No fertilizer (F_0), $N_{80}P_0K_0S_0Zn_0$ (F_1), $N_{80}P_{40}K_0S_0Zn_0$(F_2), $N_{80}P_{60}K_{40}S_0Zn_0$ (F_3), $N_{80}P_{60}K_{40}S_{30}Zn_0$ (F_4), $N_{80}P_{60}K_{40}S_{30}Zn_5$ (F_5) and two varieties of *boro* rice viz. BR2(V_1), BRRI dhan29 (V_2).The experiment was laid out in a randomized complete block design with three replications. The full dose of triple supper phosphate, muriate of potash, gypsum, zinc sulphate were applied at final land preparation. Urea was applied in three equal splits; first splits were applied at final land preparation. The second and third splits of urea were applied 30 and 50 DAT (Days After Transplanting). The nutrient supplied to the crop and their sources along with rates have been presented in treatment. 55 days age seedlings were transplanted in rows in the main field at the rate of three seedlings per hill with 25 cm × 15 cm spacing. Intercultural operations were done such as gap filling, weeding (wedding was done twice at 30 and 50 DAT), irrigation, pest control, drainage etc had done as per requirements. Five hills were randomly selected in each plot excluding border rows and uprooted before harvesting for recording the necessary data. The crops were harvested at full maturity on 30 May 2006; in each plot central 1 m ×1 m area was harvested to record the yields of grain and straw. The harvest crop of each plot was separately bundled, properly tagged and then brought to the threshing floor. The crop was threshed by pedal thresher. Grains were sun dried and cleaned. Straws were also sun dried properly. Finally, grain and straw yields were adjusted to 14% moisture and converted to t ha^{-1}. Data were compiled and tabulated in proper form for statistical analysis. The recorded data in variation plant characters were statistically analyzed to find out the significance of variation resulting from the experimental treatments. Data were analyzed using "Analysis of Variance Technique" with the help of a computer package programme MSTAT-C and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

Results and Discussion

Results obtained from the study regarding the influence of different doses fertilizers, varieties and their interactions effect on yield and yield contributing characters of rice have been presented in Tables 1 to 3.

Table 1. Effect of different doses of fertilizers on the yield and yield components of *boro* rice

Doses of fertilizers (kg ha^{-1})	Plant height (cm)	Total tillers $hill^{-1}$	Effective tillers $hill^{-1}$	Non-effective tillers $hill^{-1}$	Panicle length (cm)	Grains $panicle^{-1}$	Sterile spikelets $panicle^{-1}$	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
F_0 ($N_0P_0K_0S_0Zn_0$)	80.86d	8.09d	6.87c	1.22b	17.95e	93.48d	13.82	19.10b	2.80d	3.52d	44.30b
F_1 ($N_{80}P_0K_0S_0Zn_0$)	89.24c	11.25bc	9.45ab	1.8ab	19.80d	104.55c	14.28	19.68a	4.00c	4.63c	46.38a
F_2 ($N_{80}P_{60}K_0S_0Zn_0$)	90.18bc	10.95c	9.15b	1.78ab	19.95cd	106.93b	14.50	19.82a	3.97c	4.75bc	45.45ab
F_3 ($N_{80}P_{60}K_{40}S_0Zn_0$)	90.64ab	11.48abc	9.63ab	1.85ab	20.37bc	107.33a	13.97	19.78a	4.15bc	5.07ab	45.08ab
F_4 ($N_{80}P_{60}K_{40}S_{30}Zn_0$)	91.04ab	11.96ab	10.03a	1.93a	20.77b	108.32a	13.60	19.83a	4.47ab	5.28a	45.62ab
F_5 ($N_{80}P_{60}K_{40}S_{30}Zn_5$)	91.44a	12.18a	10.15a	2.03a	21.47a	107.60a	13.92	19.95a	4.60a	5.35a	46.05a
CV	0.252	0.214	0.168	0.149	0.121	1.25	0.511	0.80	0.091	0.093	0.425
Level of sig.	0.01	0.01	0.01	0.05	0.01	0.01	NS	0.01	0.01	0.01	0.05

In a column the treatment means having same letters or without letter do not differ significantly whereas those with dissimilar letters differ significantly (as per DMRT), * = Significant at 5% level of probability, ** = Significant at 1% level of probability, NS = Not significant

Effect of doses of fertilizers: Different fertilizer treatments exerted significant effect on almost all the characters studied except the number of sterile spikelets $panicle^{-1}$. The tallest plant (91.44 cm) was produced by the treatment F_5 which was statistically similar to those produced by the treatments F_4 and F_3 while, the shortest plant (80.86 cm) was obtained from the F_0 treatment (Table1). These results are in partial agreement with those of Miah (1974) who has reported that application of $N_{80}P_{60}K_{40}S_0Zn_0$ significantly affected plant height. Hossain and Sharma (1991) have also reported similar results. The highest number of total tillers $hill^{-1}$ (12.18) was produced from the treatment F_5 which was identical with those produced by F_4 and F_3. F_1 treatment produced the lowest number of total tillers $hill^{-1}$ (8.09). Haque *et al* (1974) also reported that total tillers $hill^{-1}$ increased with application of $N_{80}P_0K_0S_0Zn_0$. The treatment F_5 produced the maximum number of effective tillers $hill^{-1}$ (10.15) which was identical with those produced by the treatments F_4, F_3 and F_1. The lowest number of effective tillers $hill^{-1}$ (6.87) was produced by the F_0 treatment. The results of the present study pertaining to effective tillers $hill^{-1}$ are in close agreement with the findings of Miah (1974) who reported that $N_{80}P_{60}K_{40}S_0Zn_0$ produced a significant effect on effective tillers $hill^{-1}$; Dubey *et al.* (1991) also reported similar results. The highest number of non-effective tillers $hill^{-1}$ (2.03) was produced by F_5 treatment which was statistically similar to F_4, F_3, F_2 and F_1 treatments while the F_0 (control) treatment produced the lowest (1.22) one. These might be due to the higher number of tiller production $hill^{-1}$ for higher nutrient absorption where the total non-effective tillers were also higher in number. The longest (21.47 cm) and the shortest (17.95 cm) panicle were obtained from the F_5 and the F_0 (control) treatment respectively. Mondal *et al.* (1987) also reported that panicle length increased with the application of N and/or K_2O. These might be due to higher absorption of different fertilizer by the plant that favoured to produce the longer panicle. The treatment F_4 produced the maximum number of grains $panicle^{-1}$ (108.32) which was identical with those produced by F_5 and F_5 treatments. The lowest number of grains $panicle^{-1}$ (93.48) was obtained from the F_0 treatment. These results are in agreement with the findings of Refey *et al.* (1984) who noticed increased number of grains $panicle^{-1}$ with N application. Mondal *et al.* (1987) also reported that the number of grains $panicle^{-1}$ increased with the application of N and/or K_2O. The F_5 treatment produced the maximum 1000 grain weight (19.95 g) which was statistically identical with those of other treatments except the F_0 (control) treatment. These results were partially agreed with those of Mondal *et al.* (1987) who reported that 1000 grain weight increased with the application of N and/or K_2O. The F_5 treatment produced the maximum grain yield (4.60 t ha^{-1}) which was identical with those produced by F_4. The highest grain yield was the out come of maximum number of effective tiller $hill^{-1}$, maximum number of grains $panicle^{-1}$ and maximum 1000 grain weight. The treatment F_4 and F_3, and the treatments F_3, F_2 and F_1 were found similar regarding grain yield. The F_0 treatment produced the lowest grain yield (2.8 t ha^{-1}) which was the consequence of the lowest number of effective tillers hill^{-1}, lowest number of grains panicle^{-1} and lowest 1000 grain weight. These results explicitly confirm similar results obtained by Deng *et al.* (1989) who have reported that grain yield increased with the application of NPK and beneficial effect of S and Zn. Application of K was proved beneficial to significant grain yield increase by Chandarkar *et al.* (1978). Nair *et al.* (1972) and Haque *et al.* (1974) obtained higher grain yield with P application. The highest straw yield (5.35 t ha^{-1}) was obtained from the treatment F_5 which was statistically similar to those of F_4 and F_3, while the F_1 treatment produced the lowest one (3.52 t ha^{-1}). The tallest plant and highest number of total tillers hill^{-1} contributed to the maximum straw yield. These results are partially in conformity with those reported by Miah (1974) who has reported that NPK increased straw yield. Haque *et al.* (1974) noted that N increased straw yield. Dutta *et al.* (1987) noticed increased straw yield due to application of Zn. The maximum harvest index (46.05%) was recorded for F_5 treatment which maintained similarity with F_4 F_3 F_2 and F_1 treatments while the lowest harvest index (44.30%) was obtained from the F_0 (control) followed by F_2, F_3 and F_4 treatments (Table 1).

Table 2. Effect of variety on the yield and yield components of *boro* rice

Variety	Plant height (cm)	Total tillers hill^{-1}	Effective tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1 (BR2)	88.04b	10.33b	8.58b	1.75	18.85b	102.07b	13.66	19.19b	3.72b	4.44b	45.47
V_2 (BRRI dhan29)	89.75a	11.62a	9.84a	1.78	21.25a	107.32a	14.36	20.19a	4.27a	5.08a	45.48
CV	0.145	0.123	0.097	0.086	0.070	0.721	0.294	0.046	0.052	0.053	0.245
Level of significance	0.01	0.01	0.01	NS	0.01	0.01	NS	0.01	0.01	0.01	NS

In a column the treatment means having same letters or without letter do not differ significantly whereas those with dissimilar letters differ significantly (as per DMRT), * = Significant at 5% level of probability, ** = Significant at 1% level of probability, NS = Not significant

Effect of variety: Effect of variety was found significant for most of the parameters except number of non-effective tillers hill^{-1}, number of sterile spikelets panicle^{-1} and harvest index. BRRI dhan29 produced taller plants (89.75 cm) than BR2 (Table 2). BINA (1993) also reported variation in plant height among the varieties. The variation also might be due to the genetic make-up of the varieties and fertilizer treatments. The higher number of total tillers hill^{-1} (11.62) was produced by BRRI dhan29 than that of BR2. Singh and Gangwer (1989) also found variable number of total tillers hill^{-1} among different varieties. Genotypic variation might be the probable reason of this variation. BINA (1993) also reported findings. The results showed that BRRI dhan29 ranked first in number of effective tillers hill^{-1} (9.84) while BR2 produced 8.58 effective tillers hill^{-1}. The variation in this trait among varieties was also reported by BINA (1993). Panicle length showed that the longer panicle (21.25 cm) was produced by BRRI dhan29 and the shorter one (18.85 cm) by the other variety. The variation in panicle length might be due to the genetic characteristics of the varieties. Variation in panicle length among varieties was also reported by BINA (1993).

Table 3. Interaction effect of doses of fertilizers and variety on the yield and yield components of *boro* rice

Interaction (doses of fertilizers× variety)	Plant height (cm)	Total tillers hill^{-1}	Effective Tillers hill^{-1}	Non-effective tillers hill^{-1}	Panicle length (cm)	Grains panicle^{-1}	Sterile spikelets panicle^{-1}	1000 grain wt. (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
V_1F_0	79.22	7.83	6.43	1.40	16.23h	93.48b	14.36	18.97b	2.60	3.23	44.53
V_1F_1	88.55	10.57	8.97	1.60	18.77g	104.6a	14.33	19.17b	3.76	4.33	46.43
V_1F_2	89.62	10.44	8.57	1.87	18.76g	106.9a	13.50	19.20b	3.66	4.33	45.73
V_1F_3	90.21	11.70	9.03	1.67	19.13fg	107.3a	13.56	19.23b	4.00	4.90	44.86
V_1F_4	90.26	11.10	9.07	2.03	19.80ef	108.3a	13.16	19.17b	4.10	4.96	45.16
V_1F_5	90.40	11.36	9.43	1.93	20.40de	107.6a	13.03	19.43b	4.20	4.90	46.13
V_2F_0	82.50	8.33	7.30	1.03	19.67f	102.5a	13.26	19.23b	3.00	3.80	44.06
V_2F_1	89.93	11.93	9.93	2.00	20.83cd	101.2a	14.23	20.20a	4.23	4.93	46.33
V_2F_2	90.75	11.43	9.73	1.70	21.13bc	103.5a	15.50	20.43a	4.26	5.16	45.16
V_2F_3	91.07	12.26	10.23	2.03	21.60b	105.0a	14.36	20.33a	4.30	5.23	45.30
V_2F_4	91.81	12.83	11.00	1.83	21.73b	106.0a	14.03	20.50a	4.83	5.60	46.06
V_2F_5	92.48	13.00	10.87	2.13	22.53a	103.9a	14.80	20.47a	5.00	5.80	45.96
CV	0.357	0.302	0.238	0.211	0.172	1.678	0.722	0.113	0.128	0.131	0.601
Level of significance	NS	NS	NS	NS	0.05	0.05	NS	0.01	NS	NS	NS

In a column the treatment means having same letters or without letter do not differ significantly whereas those with dissimilar letters differ significantly (as per DMRT), * = Significant at 5% level of probability, ** = Significant at 1% level of probability, NS = Not significant

The higher number of grains panicle^{-1} (107.32) was obtained from BRRI dhan29 while BR2 produced 102.07 grains panicle^{-1}. Number of grains panicle^{-1} is a genetic character and this might be the probable reason for this variation. Singh and Gangwer (1989) found significant variation in number of grains panicle^{-1} among varieties.

BRRI dhan29 produced higher 1000 grain weight (20.19 g) than BR2. This variation might be due to different genetic make-up of the varieties. Singh and Gangwer (1989) also reported variable 1000 grain weight due to different varietal characters. BRRI dhan29 ranked first regarding grain yield production (4.27 t ha^{-1}) while BR2 produced 3.72 t ha^{-1}. The higher grain yield of BRRI dhan29 was the outcome of the higher number of effective tillers $hill^{-1}$, higher number of grains $panicle^{-1}$ and higher 1000 grain weight while BR2 lagged behind in all the respective traits. The variation in grain yield among varieties was also reported by Khan (1991), Ali and Murship (1993) and Islam and Ahmed (1981). It was observed that BRRI dhan29 produced higher straw yield (5.08 t ha^{-1}) than that of BR2. Taller plant and higher number of total tillers $hill^{-1}$ possibly contributed to the higher straw yield of BRRI dhan29. Variation in straw yield among varieties was also reported by Kanungo and Roul (1994) (Table 2).

Interaction effect on doses of fertilizers and variety: Interaction effect on doses of fertilizers and variety significantly affected only the panicle length, number of grains $panicle^{-1}$ and 1000 grain weight while the other studied parameters were found independent. The interaction of BRRI dhan29 (V_2) and $N_{80}P_{60}K_{40}S_{30}Zn_5$ (F_5) produced the longest $panicle^{-1}$ (22.53 cm) while BR2 (V_1) × no fertilizer (F_0) produced the lowest (16.23 cm) one (Table 3). The highest number of grains $panicle^{-1}$ (108.3) was obtained from the interaction of BR2 (V_1) and $N_{80}P_{60}K_{40}S_{30}Zn_0$ (F_4) which was statistically identical with all other interactions except BR2 (V_1) × no fertilizer (F_0) which produced the lowest number of grains $panicle^{-1}$(93.48). The interaction BRRI dhan29 (V_2) and $N_{80}P_{60}K_{40}S_{30}Zn_0$ (F_4) produced the highest 1000 grain weight (20.5 g) which was statistically similar to those produced by V_2F_5, V_2F_3 and V_2F_1 while BR2 (V_1) × no fertilizer (F_0) produced the lowest 1000 grain weight (18.97 g) closely followed by V_1F_1, V_1F_2, V_1F_3, V_1F_4, V_1F_5 and V_2F_0 treatment combinations (Table 3).

From the above findings it is evident that application of different doses of fertilizers specially the balanced levels of $N_{80}P_{60}K_{40}S_{30}Zn_5$ application increased the yield and yield contributing characters and eventually grain and straw yields of both the varieties of rice in *boro* season, and BRRI dhan29 performed better than BR2 in this season.

References

Ali, M. Y. and Murship, M.G. 1993. Effect of age of seedlings on yield and economic performance of late transplant aman rice. Bangladesh J. Agril. Sci. 20(2): 345-359.

BBS (Bangladesh Bureau of Statistics). 2005. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics. Ministry of Planning. Dhaka.

BINA (Bangladesh Institute of Nuclear Agriculture). 1993. Annual Report for 1992-93. Bangladesh Inst. Nucl. Agric., Mymensingh, Bangladesh. p.143.

Brady, N. C. 1988. The Nature and Properties of Soils. Eurasia Publishing House Ltd., New Delhi, India. p. 78.

Chandarkar, B.L., Khan, R.A., chavhan, D.V.S. and Dubey, B.D. 1978. Response of dwarf rice to potash application under different nitrogen and phosphorus conditions. Indian Potash J. 3(2): 21-23.

Deng, C.Z., Xu, Y., Xie, K.J., Jin, G. F. and Hou, J.U. 1989. Sulphur imbalance in paddy fields in Dehong Prefecture, Yunnan Province and the effects of phosphogypsum in increasing yields. J.Ecol.(Beijing)8(3): 49-52. [cited from Field Crop Abst. (1990), 43(6): 507].

Dubey, O.P., Upadhayaya, S.P., Dixit, J.P., and Grag, D.C. 1991. Response of short duration paddy varieties to nitrogen under rainfed condition. Indian J. Agron. 36(2): 255-256.

Dutta, R.K., Muslimuddin and Rahman, L. 1987. Yield and flowering of rice in relation to fertilizer zinc sulphate. Intl. Rice Comm. Newsl. 36(1): 16-22.

Gomez, K.A. and Gomez, A.A. 1984. Statistical Procedure for Agricultural Research. 2nd Ed. John Wiley and Sons. New York, pp.643-645.

Haque, S.A., Bhuiya, Z. H., Talukder, M.A.S. and Haque, M.S. 1974. Effect of split application of urea N on the growth and yield of rice (IR20 variety). Bangladesh J. Agric. Sci. 1(2): 30-35.

Hossain, S.M. and Sharma, U.C. 1991. Response on rice to nitrogen fertilizer in acidic soil of Nagaland. Indian J. Agril. Sci. 61(9): 660-664.

Islam, M.A. and Ahmed, J.U. 1981. Effect of age of seedling on the yield of transplant aman cultivars. Bangladesh J. Agril. Sci. 8(2): 175-179.

Islam, R., Hossain, M.S.A., Howlader, A.S., Islam, A., Mondal, R. and Huq, S.M.I. 1987. Effect of sulphur on rice under flooded condition. Intl. J. Trop. Agric. 5(2): 92-101. [cited from Rice Abst. (1988), 11(6): 307].

Kanungo, A.P. and Roul, P.K. 1994. Response of transplanted summer rice genotypes to varying levels of fertility and plant density. Indian J. Agron. 39(2): 219.

Khan, H. R. 1991. Effect of gypsum, zinc and saline water on the yield and nutrient uptake by rice in a coastal saline soil. Intl. J. Trop. Agric. 9(3): 225-233.

MoA (Ministry of Agriculture), 2007. Hand book of agricultural Statistics,December 2007 Ministry of Agriculture, Govt. People's Republic of Bangladesh.

Miah, A.M.J. 1974. Effect of NPK dose on rice cultivars. Unpublished M.Sc. (Ag.)Thesis, Bangladesh Agril. Univ. 35.

Mondal, S.S., Darmahapatra, A.N. and chaterjee, B.N. 1987. Effect of high rate of potassium and nitrogen on rice yield components. Environ. and Eco. 5(20: 300-303.

Nair, R.R., Pillai, G.R., Pisharochy, P.N. and Gopal Krishan, R. 1972. Response of rice (*Oryza sativa* L.) to different types of phosphatic fertilizers in acid soils. Technology 9(213): 178-180.

Refey, A., Khan, P.A. and Srivastava, V.c. 1989. Effect of nitrogen on growth, yield and nutrient uptake of upland rice. Indian J. Agro. 34(1): 133-135.

Singh, G. and Singh, O.P. 1989. Comparative studies on production potentials in traditional tall and improved rice cultivars. J. Andaman Sci. Assoc. 5(1): 81-82.

Tisdale, S.L. and Nelson, N.L. 1966. Soil Fertility and Fertilizers. The McGmillan Co., 866. Third Avenue, New York. 10022. pp. 71-110.