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Effect of urea super granules, prilled urea and poultry manure on the growth performance of transplant *Aman* rice varieties

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Abstract: An experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh in transplant *Aman* season of 2008 to find out the effect of urea supergranules (USG), prilled urea (PU) and poultry manure (PM) on the growth performance of transplant *Aman* rice varieties. Two transplant *Aman* rice varieties viz. BRRI dhan41 and BRRI dhan46 and ten levels of integrated nutrient management encompassing USG, PU and PM were tested following randomized complete block design with three replications. Data were taken at 75 days after transplanting (DAT). The growth parameters were considered viz. plant height, number of tiller hill^{-1}, leaf area, dry matter, leaf area index (LAI) and crop growth rate (CGR). Grain yield was calculated for comparing the corresponding growth parameters. In case of variety, fertilizers and interaction most of the growth parameters were significantly influenced at 1% level of significance. The highest grain yield (5.27 t ha^{-1}) was obtained from variety BRRI dhan41 and full dose of USG (1.8g) and other inorganic fertilizers, which was obtain from due to might be the highest plant height (84.08cm), tiller number (13.73), leaf area (4354.37 cm^2), dry matter (37.53), lower LAI (0.61) and highest CGR (0.0088) at 75 DAT and the lowest yield was obtained in the BRRI dhan46 and control treatment. It was assessed that a considerable portion (31.25%) of PU nitrogen could be saved by using USG (1.8g) together with other inorganic fertilizers or with PM at 2.5 t ha^{-1}.
Key words: Urea supergranules, prilled urea, poultry manure, growth performance, transplant *Aman* rice variety.

Introduction

Rice is the major food crop and staple food of Bangladesh. But the average yield of rice is poor in Bangladesh, only 2.6 t/ha (BBS, 2008). On the other hand, rice production area is decreasing day by day due to high population pressure. The possibility of horizontal expansion of rice production area has come to a stand still (Hamid, 1991). Therefore, attempts should be taken to increase the yield per unit area. For vertical expansion, the use of modern production technologies should be included, among which high yielding varieties and fertilizer management are remarkable ones.

Variety is the most important factor in rice production. Selection of potential variety, planting in appropriate method and application of optimum amount of nutrient elements, can play an important role in increasing yield and national income.

According to Crasswell and De Datta (1980), broadcast application of urea on the surface soil causes losses upto 50% but point placement of Urea super granules (USG) at 10 cm depth may result in negligible loss. USG is a fertilizer that can be applied in the rice root zone at 8-10 cm depth of soil (reduced zone of rice soil) which can save 30% nitrogen than prilled urea, increase absorption rate, improve soil health and ultimately increase the rice yield (Savant *et al*., 1991). The recent literatures on nitrogen use efficiency of rice, in general, would indicate the superiority of root zone placement of USG as it would reduce the magnitude of nitrogen losses to a considerable extent and increase its use efficiency for better grain production (Crasswell and De Datta , 1980; Pillai, 1981).

Almost all soils of Bangladesh are deficient in nitrogen mainly due to low level of organic matter caused by rapid decomposition due to warm climate, continuous intensive cropping, cultivation of high yielding varieties and no adding of organic matter. Most of the soils of Bangladesh have less than 1.5% and in some cases less than 1% organic matter. Poultry manure (PM) may play a vital role in soil fertility and productivity improvement thereby reducing the use of chemical fertilizers and environmental pollution.

It is true that sustainable production of crops can not be maintained by using only chemical fertilizers and similarly it is not possible to obtain higher crop yield by using organic manure alone (Bair, 1990). In near future, fertilizer N is likely to be even more costly. This situation in turn will pose a serious threat to food security for the vast millions of people of this country. The use of PM and its proper management may reduce the need for chemical fertilizer allowing the small farmer s to save part of their cost of crop production. The present study was, therefore, carried out to observe the integrated nutrient management by using USG, PU and PM on the growth performance of transplant *Aman* rice.

Materials and Methods

The experiment was carried out at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh in transplant *Aman* season 2008. The experiment consisted of two transplanted *Aman* rice varieties viz. V_1=BRRI dhan41 and V_2=BRRI dhan46; and ten levels of integrated nutrient management viz. T_1 = Control (No PM and NPKSZn fertilizers), T_2 = PM at 5 t ha^{-1},T_3 = PM at 2.5 t ha^{-1}, T_4= Recommended dose of PU and other inorganic fertilizers (i.e. 80,60,40,10,5 kg of N, P_2O_5, K_2O, S, $ZnSO_4$, respectively ha^{-1}), T_5 = Full dose of USG and other inorganic fertilizers (i.e. 55,60,40,10,5 kg of N, P2O5, K2O, S, ZnSO4, respectively ha^{-1}), T_6 = ½ PU and PKSZn + PM at 2.5 t ha^{-1}, T_7 = 0.9 g USG + PM at 2.5 t ha^{-1}, T_8 = 0.9 g USG + PM at 5 t ha^{-1}, T_9 = 1.8 g USG (full dose for transplant *Aman*) + PM at 2.5 t ha^{-1} and T_{10} = Full dose of PU (for transplant *Aman)* + PM at 2.5 t ha^{-1}. The experiment was laid out in a randomized complete block design with three replications. The unit plot size of the experiment was 4.0m × 2.5m. Thirty- day old seedlings were transplanted at spacing of 20 cm×20 cm with two seedlings hill^{-1}. All the fertilizers except prilled urea were applied as basal at final land preparation. Prilled urea was top dressed in three equal splits at 15, 30 and 45 DATs. Gap filling, weeding, irrigation and other necessary intercultural operations were done in proper time. Data on growth parameters viz., plant height, tiller number, leaf area, dry matter, leaf area index and CGR were collected at 75 DAT. The crops were harvested at full maturity. The maturity of crops was determined when some 80% of the grains became golden yellow in colour. Five sample plants were randomly selected and uprooted prior to harvesting from each plot excluding border rows to record data on yield contributing characters. Central 5 m^2 area in each plot was harvested to record grain and straw yields. Grain and straw yields plot $^{-1}$ were recorded after threshing by a pedal thresher, winnowing and sun drying properly. The yield values were adjusted to 12% moisture content and converted to t ha^{-1}. All the collected data were analyzed following standard statistical procedure and differences among treatment means were adjudged by Duncan's Multiple Range Test (DMRT) (Gomez and Gomez, 1984).

Results and Discussion

Varietal performance: In case of varietal effect most of the growth parameters viz., plant height, tiller number, leaf area, dry matter, LAI, CGR and grain yield were significantly influenced at 1% level of significance at 75 DAT. Plant height, leaf area and dry matter were increasing up to 75 DAT. Results showed that variety BRRI dhan41 produced higher grain yield (4.39 t ha^{-1}) than that of BRRI dhan46 (4.28 t ha^{-1}). Higher grain yield in BRRI dhan41 was due mainly to higher of plant height (77.25cm), tiller number (12.58), leaf area (3134.45cm^2), dry matter (28.12), LAI (0.69) at 75 DAT and lower CGR (0.0053) at 75 DAT (Table 1). These results are similar to Roy *et al*. (2007).

Table 1. Effect of variety on the growth characters at 75 DAT of transplant *Aman* rice

Variety	Plant height (cm)	No. of tillers hill^{-1}	Leaf Area hill^{-1} (cm^2)	Dry matter hill^{-1} (g)	LAI	CGR (gg^{-1} cm^{-2})	Grain yield (t ha^{-1})
V1	77.25a	12.35	3134.45a	28.12	0.69	0.0053b	4.39a
V2	75.34b	12.58	2426.75b	24.39	0.49	0.0075a	4.28b
$S\bar{X}$	0.90	0.22	7.08	0.08	0.03	0.0001	0.03
Level of significance	0.01	NS	0.01	NS	NS	0.01	0.01
CV (%)	6.45	9.63	1.40	1.62	28.27	8.75	3.98

In a column, figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.
NS = Non significant, V1= BRRI dhan41 and V2= BRRI dhan46

Table 2. Effect of fertilizer on the growth characters at 75 DAT of transplant *Aman* rice

Fertilizer	Plant height (cm)	No. of tillers hill^{-1}	Leaf Area hill^{-1} (cm^2)	Dry matter hill^{-1} (g)	LAI	CGR (gg^{-1} cm^{-2})	Grain yield (t ha^{-1})
T1	65.80d	10.57d	2407.44	20.00f	0.35c	0.0049c	3.04f
T2	69.82d	11.54cd	2586.64	22.97e	0.75a	0.0055bc	3.49e
T3	70.65cd	11.77bcd	2739.44	25.66d	0.69ab	0.007ab	4.16d
T4	79.70ab	12.57abc	2688.24	25.71d	0.51bc	0.0065abc	4.22d
T5	84.07a	13.48a	3395.82	32.53a	0.47bc	0.0065abc	5.17a
T6	81.65ab	13.30ab	2792.83	25.84d	0.73a	0.0047c	4.50c
T7	80.05ab	11.53cd	2899.99	27.55c	0.59ab	0.0067abc	4.30cd
T8	75.97bc	13.23ab	2851.80	27.26c	0.54abc	0.0065abc	4.50c
T9	76.97b	13.23ab	2589.22	25.64d	0.65ab	0.008a	5.06ab
T10	78.23ab	13.47a	2854.57	29.40b	0.59ab	0.0079a	4.91b
$S\bar{X}$	2.01	0.49	15.84	0.17	0.07	0.0002	0.07
Level of significance	0.01	0.01	NS	0.01	0.01	0.01	0.01
CV (%)	6.45	9.63	1.40	1.62	28.27	8.75	3.98

In a column, figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT.
NS =Not significant, T_1 = Control (No PM and NPKSZn fertilizers), T_2 = PM at 5 t ha^{-1}, T_3 = PM at 2.5 t ha^{-1}, T_4 = Recommended dose of PU and other inorganic fertilizers (i.e. 80,60,40,10,5 kg of N, P_2O_5, K_2O, S, $ZnSO_4$, respectively ha^{-1}), T_5 = Full dose of USG and other inorganic fertilizers (i.e. 55,60,40,10,5 kg of N, P2O5, K2O, S, ZnSO4, respectively ha^{-1}), T_6 = ½ PU and PKSZn + PM at 2.5 t ha^{-1}, T_7 = 0.9 g USG + PM at 2.5 t ha^{-1}, T_8 = 0.9 g USG + PM at 5 t ha^{-1}, T_9 = 1.8 g USG (full dose for transplant *Aman)* + PM at 2.5 t ha^{-1}, T_{10} = Full dose of PU for transplant *Aman* + PM at 2.5 t ha^{-1}.

Integrated nutrient management: For fertilizer effect all the growth parameters were significantly influenced at 1% level of significance except leaf area. Plant height was increasing up to 75 DAT. The highest plant height (84.07 cm) was found from full dose of USG with other inorganic fertilizers (T_5) at 75 DAT and the lowest one (65.80 cm) was found from control treatment (T_1). Similar results were reported by IRRI (1975). The highest tiller number was 13.48 in T_5 and lowest 10.57 in T_1. Leaf area and dry matter were also increasing up to 75 DAT. The highest leaf area (3395.82cm^2) and dry matter (32.53) were at 75 DAT from T_5 and the lowest were 2407.44cm^2 and 20.00 from T_1. The highest LAI was 0.75 from PM at 5 t ha^{-1} and the lowest was 0.35 at 75 DAT from T_1. The highest CGR was 0.008 from 1.8g USG (T_9) and the lowest one was 0.0049 from T_1. The highest grain yield (5.17 t ha^{-1}) obtained from full dose of USG (1.8g) with other inorganic fertilizers (T_5) while the lowest grain yield (3.04 t ha^{-1}) was obtained from control treatment. However, full dose of USG + PM at 2.5 t ha^{-1} was as good as T_5. Encouraging results of PM in combination with chemical fertilizers regarding yield improvement of transplant *Aman* rice have been reported elsewhere (Hasan *et al*., 2004, Sarkar *et al.*, 2007).

Interaction of variety and integrated nutrient management: For interaction effect, values of the all other DATs were significantly influenced at 1% level of significance except plant height, tiller number and LAI. The plant height was increasing chronologically up to 75 DAT. The highest plant height was 84.08 cm at 75 DAT found in the BRRI dhan41×1.8g USG with other inorganic fertilizers (V_1T_5) and the lowest one was 65.66 cm found in control treatment (V_2T_1). The highest tiller number was from 13.73 in V_2T_6 and the lowest one was 10.39 in V_2T_1. It might be due to the higher mortality tendency of non effective tiller. Leaf area was increasing trend up to 75 DAT. The highest Leaf area was 4354.37 cm2 at 75 DAT in V_1T_5 and the lowest one was 2097.85 cm^2 in BRRI dhan46 with recommended dose of PU and other inorganic fertilizers (V_2T_4). Dry matter was chronologically increased up to 75 DAT. The highest dry matter was 37.53 at 75 DAT in V_1T_5 but the lowest dry matter was 19.15 in V_1T_1. The maximum LAI was 0.88 in V_1T_2 and the lowest 0.34 at 75 DAT in V_2T_5. The highest CGR was 0.0088 in BRRI dhan46 with full dose of PU for transplant *Aman* + PM at 2.5 t ha^{-1} (V_2T_{10}) and the lowest one was 0.003 in V_1T_2 (Table 3).

Table 3. Interaction effect of variety and fertilizer on the growth characters at 75 DAT of transplant *Aman* rice

Treatment V×T	Plant height (cm)	No. of tillers $hill^{-1}$	Leaf Area $hill^{-1}$ (cm^2)	Dry matter $hill^{-1}$ (g)	LAI	CGR (gg^{-1} cm^{-2})	Grain yield (t ha^{-1})
V1×T1	65.95	10.75	2547.79ij	19.15m	0.43	0.004g	3.35 h
V1×T2	73.03	11.68	2786.79g	22.46k	0.88	0.003fg	3.58 h
V1×T3	71.60	11.35	3199.51cd	27.87d	0.82	0.0049f	4.13 g
V1×T4	78.20	12.40	3278.64b	29.98c	0.59	0.0056e	4.16 g
V1×T5	84.08	13.43	4354.37a	37.53a	0.61	0.006de	5.27a
V1×T6	83.13	12.87	3077.22e	26.68fg	0.83	0.0034de	4.38 efg
V1×T7	81.53	11.13	3227.24c	29.75c	0.61	0.006de	4.32 efg
V1×T8	75.80	13.40	2987.50f	28.12d	0.60	0.0052d	4.50 def
V1×T9	80.20	13.07	2696.39h	26.97ef	0.77	0.0082d	5.167ab
V1×T10	78.93	13.47	3189.07d	32.68b	0.72	0.007d	5.027abc
V2×T1	65.66	10.39	2267.09o	20.85l	0.26	0.0059c	2.7i
V2×T2	66.62	11.40	2386.49n	23.48j	0.61	0.0081c	3.40 h
V2×T3	69.70	12.20	2279.37o	23.44j	0.55	0.009bc	4.18 fg
V2×T4	81.20	12.73	2097.85p	21.45l	0.43	0.0074bc	4.28 fg
V2×T5	84.07	13.52	2437.27m	27.52de	0.34	0.007bc	5.07abc
V2×T6	80.17	13.73	2508.43kl	24.99hi	0.63	0.006bc	4.62de
V2×T7	78.57	11.93	2572.75i	25.35h	0.58	0.0074ab	4.28 fg
V2×T8	76.13	13.07	2716.11h	26.41fg	0.49	0.0078ab	4.50 def
V2×T9	73.73	13.40	2482.04l	24.32i	0.52	0.0077a	4.957bc
V2×T10	77.53	13.47	2520.07jk	26.13g	0.45	0.0088a	4.80 cd
$S\overline{X}$	2.84	0.69	22.40	0.25	0.10	0.0003	0.10
Level of significance	NS	NS	0.01	0.01	NS	0.01	0.01
CV (%)	6.45	9.63	1.40	1.62	28.27	8.75	3.98

In a column, figures with same letters or without letters do not differ significantly whereas figures with dissimilar letter differ significantly as per DMRT. NS =Not significant, V= Variety and T= Fertilizers, V1= BRRI dhan41 and V2= BRRI dhan46, T_1 = Control (No PM and NPKSZn fertilizers), T_2 = PM at 5 t ha^{-1}, T_3 = PM at 2.5 t ha^{-1}, T_4 = Recommended dose of PU and other inorganic fertilizers (i.e. 80,60,40,10,5 kg of N, P_2O_5, K_2O, S, $ZnSO_4$, respectively ha^{-1}), T_5 = Full dose of USG and other inorganic fertilizers (i.e. 55,60,40,10,5 kg of N, P2O5, K2O, S, ZnSO4, respectively ha^{-1}), T_6 = ½ PU and PKSZn + PM at 2.5 t ha^{-1}, T_7 = 0.9 g USG + PM at 2.5 t ha^{-1}, T_8 = 0.9 g USG + PM at 5 t ha^{-1}, T_9 = 1.8 g USG (full dose for transplant *Aman)* + PM at 2.5 t ha^{-1}, T_{10} = Full dose of PU for transplant *Aman* + PM at 2.5 t ha^{-1}.

The highest grain yield (5.27 t ha^{-1}) was obtained in BRRI dhan41×1.8g USG with other inorganic fertilizers, which was as good as the same dose of USG with PM at 2.5 tha^{-1}. The lowest grain yield was obtained from control treatment. The inefficiency of nitrogen use was attributed to various losses such as ammonia volatilization, denitrification, leaching and runoff (Crasswel and Vlek, 1979). It was also observed in the present study that about 31.25% of PU nitrogen could be saved by using full dose of USG (1.8g) with other inorganic fertilizers (PKSZn) or full dose of USG (1.8g) with PM at 2.5 t ha^{-1} in BRRI Dhan41 production enhancing results of PM in combination with chemical fertilizers regarding yield improvement of transplant *Aman* rice have been reported elsewhere (Hasan *et al.*, 2004).

In transplant *Aman* season, BRRI dhan41 can be successfully cultivated with full dose of USG (1.8g) and other inorganic fertilizers (PKSZn) to obtain the highest grain yield which effects in the growth performance. It is also observed that in transplant *Aman* season full dose of USG with other inorganic fertilizers (PKSZn) showed the best growth performance.

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