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Comparison of different application methods of USG for wetland rice

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ABSTRACT

Two experiments were conducted at farmer's field, Alampur, Sylhet during T. aman season 2012 and Boro season 2013 in order to find out the suitable application method of USG (urea super granule) for wetland rice. Six treatment combinations were tested in T. aman season: T1 = N –control (N0), T2 = USG deep-placement @ 50 kg N/ha, T3 = USG broadcast @ 50 kg N/ha, T4 = USG deep-placement @ 75 kg N/ha, T5 = USG broadcast @ 75 kg N/ha, T6 = Prilled urea on STB (soil test based). BRRIdhan 41 was used as test crop. Six treatment combinations were tested in Boro season: T1 = N –control (N0), T2 = USG deep-placement @ 75 kg N/ha, T3 = USG broadcast @ 75 kg N/ha, T4 = USG deep-placement @ 125 kg N/ha, T5 = USG broadcast @ 125 kg N/ha, T6 = Prilled urea on STB. The blanket doses of fertilizers were applied on STB. The experiments were laid out in randomized complete block design with 3 replications of each treatment. The sources of N, P, K & S were USG, triple super phosphate (TSP), muriate of potash (MP) and gypsum. Cumulative data showed that the treatment T4 where USG was deep-placement produced the maximum yield and also found superior in terms of economic point of view.

Key words: urea super granule (USG), different application method, wetland rice

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INTRODUCTION

Rice is one of the main food crops in the world, especially in Asia and Africa. Labor shortage is the great problem in rice production due to migration of people to town and need mechanization for rice production (Mohammed et al 2011). About 95% of the total rice area of Bangladesh is on wetland soils (Huq and Kamal, 1993). Nitrogen (N) fertilizer is one of the most essential chemical fertilizers for growing rice all over the world (Prashad et al 1979). N fertilizer plays vital role in the production of modern high yielding rice varieties. Unfortunately, the efficiency of N fertilizer in wetland rice culture is only about 30% of the applied N. This low N use efficiency in wetland rice culture is attributed to N loss from the rice fields due to NH_3 volatilization, de-nitrification, runoff and leaching. High pH, high NH_4-N concentration in the flood water, high temperature and high wind velocity are the factors which have been found to enhance NH_3 volatilization. Deep point placement of urea super granule (USG) decreases the de-nitrification process and minimizes urea concentration in flood water thus reducing N loss and improving N absorption by the rice crop. Deep placement of N fertilizer is an alternative for increasing the N use efficiency of wetland rice besides minimizing the adverse effects of fertilizers on the environment (Bautista et al 2001) with minimal loss (Ahamed, 2012). Keeping these points in mind the present study was undertaken in BRRI farm, Gazipur, Bangladesh to evaluate the different application method of USG for growing wetland rice

MATERIALS AND METHODS

Two experiments were conducted at farmer's field, Alampur, Sylhet during T. aman season 2012 and Boro season 2013. The initial soil properties of the experimental site are presented in table 1. Soil texture, pH, organic matter, available P and S, exchangeable K, Na, Ca and Mg were determined

following standard methods (Black, 1965; Jackson, 1962; Walkley and Black, 1935; Olsen *et al.*, 1954 and Page *et al.*, 1982). The following six treatment combinations were tested in T. aman season: T_1 = N –control (N_0), T_2 = USG deep-placement @ 50 kg N/ha, T_3 = USG broadcast @ 50 kg N/ha, T_4 = USG deep-placement @ 75 kg N/ha, T_5 = USG broadcast @ 75 kg N/ha, T_6 = Prilled urea on STB. Fertilizer doses on STB were 75 kg N, 18 kg P, 38 kg K and 13 kg S /ha and was applied as urea, TSP, MP and gypsum respectively. BRRIdhan 41 was used as test crop. Thirty days old 2-3 seedling/hill were transplanted with 20 cm x 20 cm spacing. The following six treatment combinations were tested in Boro season: T_1 = N –control (N_0), T_2 = USG deep-placement @ 75 kg N/ha, T_3 = USG broadcast @ 75 kg N/ha, T_4 = USG deep-placement @ 125 kg N/ha, T_5 = USG broadcast @ 125 kg N/ha, T_6 = Prilled urea on STB. Fertilizer doses on STB were 110 kg N, 30 kg P, 60 kg K and 23 kg S /ha and was applied as urea, TSP, MP and gypsum respectively. BRRIdhan 29 was used as test crop. Fifty days old 2-3 seedling/hill were transplanted with 20 cm x 20 cm spacing. The experiments were laid out in a randomized complete block design with three replications having unit plot size of 6m x 4m. USG broadcast, triple super phosphate (TSP), muriate of potash (MP and Gypsum were applied at final land preparation. USG deep-placement was done at 7 days. Urea was applied into three equal splits, 1/3 basal, 1/3rd maximum tillering stage and the remaining 1/3rd at panicle initiation stage. Necessary intercultural operations were done as and when required. At maturity, the crop was harvested from 5 m^2 area for grain and straw yield and grain yield was adjusted to 14% moisture content. The plant height, tiller, panicle, filled grain and unfilled grain production and grain & straw yield were recorded. Finally economic analyses were done for net benefit and marginal rate of return.

RESULTS AND DISCUSSION

Growth and Yield

T. aman season

Application of USG increased the plant height of rice over control. Highest plant height was found in treatment T_2 (USG deep-placement @ 50 kg N/ha) followed by treatment T_4 (USG deep-placement @ 75 kg N/ha). Application of USG statistically increased the tiller and panicle number and grain yield of rice over control. Maximum number of tiller was recorded in treatment T_4 followed by treatment T_3 (USG broadcast @ 50 kg N/ha) and T_5 (USG broadcast @ 75 kg N/ha). On the other hand treatment T_4 produced the highest number of panicle followed by T_5. Maximum grain yield was recorded in treatment T_4 followed by treatment T_5. Application of USG increased the straw yield of rice over control. Highest straw yield was observed in treatment T_5 followed by treatment T_4 (table 2). It is appeared from the results that treatment T_4 where USG deep-placement @ 75 kg N/ha gave highest yield.

Boro season

Application of USG increased the plant height, tiller and panicle number of rice over control. Highest plant height was found in treatment T_5 (USG broadcast @ 125 kg N/ha) followed by treatment T_2 (USG deep-placement @ 75 kg N/ha) and T_4 (USG deep-placement @ 125 kg N/ha). Maximum number of tiller and panicle was recorded in treatment T_4 followed by treatment T_5. Application of USG increased the grain and straw yield of rice over control. Maximum grain and straw yield was recorded in treatment T_4 followed by treatment T_5 (table 3). It is appeared from the results that treatment T_4 where USG deep-placement @ 125 kg N/ha gave highest yield.

Economic analysis

Net benefit

Economic analysis on partial budget of the experiment is presented in table 4 and table 5. The net benefit of each treatment is calculated by subtracting the total costs that vary from the gross field benefit. The total costs that vary are the sum of all the costs that vary for a particular treatment. The maximum net benefit was achieved in treatment T_4 followed by T_5 (both season).

Table 1
Initial soil characteristics of the experimental site of different application methods of USG fertilizer, farmer's field, Alampur, Sylhet, T. Aman 2012 and Boro 2013

Parameters	Value
Texture	Clay loam
pH	5.84
Total N (%)	0.14 (low)
Available P(ppm)	5.77 (low)
Exchangeable K(meq/100g soil)	0.14 (Medium)
Available S (ppm)	6.56 (low)
Available Zn (ppm)	1.5 (high)

Dominance and marginal analysis

The analysis has been done in stepwise manner, passing from the treatment with the lowest costs that vary to the next considering. As the increase in cost, the net benefit would be increased. But the net benefits are lower in T_2, T_3 and T_5 as the cost increase. Thus T_2, T_3, T_5 are cost dominated treatment and can be eliminated for further consideration (table 6). Similarly, T_3 and T_5 are cost dominated treatment and can be eliminated for further consideration (table 7).

Table 2
Effect of different application methods of USG on the growth and yield of wetland rice, farmer's field, Alampur, Sylhet, T. Aman 2012

Treatment*	Pl. ht. (cm)	Till. No./m^2	Pan. No./m^2	%Sterility	1000 g wt.	GY(t/ha)	SY(t/ha)
T1	113	184	170	25	25	2.80	3.42
T2	130	215	200	19	26	4.20	5.42
T3	125	217	201	25	27	4.15	5.43
T4	129	228	211	18	26	4.85	5.87
T5	125	217	206	24	26	4.27	6.04
T6	123	199	186	24	26	4.12	5.85
LSD (5%)	8	32	28	4	2	0.51	0.92

*T1 = N –control (N0), T2 = USG deep-placement @ 50 kg N/ha, T3 = USG broadcast @ 50 kg N/ha, T4 = USG deep-placement @ 75 kg N/ha, T5 = USG broadcast @ 75 kg N/ha, T6 = Prilled urea on STB.

Table 3
Effect of different application methods of USG on the growth and yield of wetland rice, farmer's field, Alampur, Boro 2013

Treatment*	Pl. ht. (cm)	Till. No./m^2	Pan. No./m^2	%Sterility	1000 g wt.	GY(t/ha)	SY(t/ha)
T1	80	133	125	22	22	2.12	2.54
T2	93	265	254	18	23	4.98	5.43
T3	92	217	209	20	22	4.66	4.88
T4	93	315	301	18	21	5.86	6.11
T5	94	281	274	23	23	5.11	5.92
T6	89	214	204	24	23	4.86	5.14
LSD (5%)	9	29	31	7	1	0.69	0.59

*T_1 = N –control (N_0), T_2 = USG deep-placement @ 75 kg N/ha, T_3 = USG broadcast @ 75 kg N/ha, T_4 = USG deep-placement @ 125 kg N/ha, T_5 = USG broadcast @ 125 kg N/ha, T_6 = Prilled urea on STB.

Table 4
Partial budget for the experiment different application methods of USG fertilizer for rice production, farmer's field, Alampur, T. Aman 2012

Particulars	Treatments					
	T1	T2	T3	T4	T5	T6
Grain yield (t/ha)	2.8	4.2	4.15	4.85	4.27	4.12
Straw yield (t/ha)	3.42	5.42	5.43	5.87	6.04	5.85
Gross field benefit, grain (Tk/ha)	28000	42000	41500	48500	42700	41200
Gross field benefit, straw (Tk/ha)	6840	10840	10860	11740	12080	11700
Total gross field benefit (Tk/ha)	34840	52840	52360	60240	54780	52900
Total gross field cost (Tk/ha)	2381	3491	3491	4046	4046	3380
Net benefit (Tk/ha)	32459	49349	48869	56194	50734	49520

Urea = Tk. 20.00 /kg, TSP= Tk 26.00/kg, MP= Tk.25.00./kg , Gypsum= Tk. 10.00/kg, USG =Tk. 20.00/kg, Paddy= Tk.15.00/kg and straw= Tk. 3.00 /kg and Minimum rate of return = 100%

Table 5
Partial budget for the experiment different application methods of USG fertilizer for rice production, farmer's field, Alampur, Boro 2013

Particulars	Treatments					
	T1	T2	T3	T4	T5	T6
Grain yield (t/ha)	2.12	4.98	4.66	5.86	5.11	4.86
Straw yield (t/ha)	2.54	5.43	4.88	6.11	5.92	5.14
Gross field benefit, grain (Tk/ha)	21200	49800	46600	58600	51100	48600
Gross field benefit, straw (Tk/ha)	5080	10860	9760	12220	11840	10280
Total gross field benefit (Tk/ha)	26280	60660	56360	70820	62940	58880
Total gross field cost (Tk/ha)	3939	5604	5604	6714	6714	5405
Net benefit (Tk/ha)	22341	55056	50756	64106	56226	53475

Urea = Tk. 20.00 /kg, TSP= Tk 26.00/kg, MP= Tk.25.00./kg, Gypsum= Tk. 10.00/kg, USG =Tk. 20.00/kg, Paddy= Tk.15.00/kg and straw= Tk. 3.00 /kg and Minimum rate of return = 100%

It is well known that the minimum marginal rate of return for the crop is 100%. If the marginal rate of return of the change from the first to the second treatment is equal or above the minimum marginal rate of return then the next comparison has been made between second and third treatment (not between first and third). This comparison has been continued (i.e. increasing level of investment) until the marginal rate of return falls below the minimum rate of return.

In the experiment the maximum marginal rate of return between T_2 and T_4 is 1002% (T. aman season) and 815% (Boro season) well above the 100% minimum. Farmers will continue to invest as long as the returns to each extra unit invested (measured by MRR) which are higher than the cost of the extra invested (measured by the minimum acceptable rate of return) (table 6 and 7). Thus it can be concluded that T_4 is the most economically viable treatment of the experiments.

Table 6
Dominance and marginal analysis of different application methods of USG fertilizer for rice production, farmer's field, Alampur, T. aman 2012

Treatments*	Total costs that vary (Tk./ha)	Net benefit (Tk./ha)	Marginal rate of return (%)
T1	2381	32459	
T6	3380	49520	
T2	3491	49349D	1002
T3	3491	48869D	
T4	4046	56194	
T5	4046	50734D	

D=Dominated; * T_1 = N –control (N_0), T_2 = USG deep-placement @ 50 kg N/ha, T_3 = USG broadcast @ 50 kg N/ha, T_4 = USG deep-placement @ 75 kg N/ha, T_5 = USG broadcast @ 75 kg N/ha, T_6 = Prilled urea on STB.

Table 7
Dominance and marginal analysis of different application methods of USG fertilizer for rice production, farmer's field, Alampur, Boro 2013

Treatments*	Total costs that vary (Tk./ha)	Net benefit (Tk./ha)	Marginal rate of return (%)
T1	3939	22341	
T6	5405	53475	794
T2	5604	55056	
T3	5604	50756 D	815
T4	6714	64106	
T5	6714	56226 D	

D=Dominated; * T_1 = N –control (N_0), T_2 = USG deep-placement @ 75 kg N/ha, T_3 = USG broadcast @ 75 kg N/ha, T_4 = USG deep-placement @ 125 kg N/ha, T_5 = USG broadcast @ 125 kg N/ha, T_6 = Prilled urea on STB.

USG deep-placement appeared to be the economically most viable treatment of these experiments and also produced higher yield than that of USG broadcast and application of prilled urea. USG deep-placement is better than broadcast and prilled urea. USG is a new technology it requires extensive and repeated training to extension worker and farmers. Deep point placement of USG requires trained and extra labours. USG is not always available within a reasonable distance from farmers who desire to use it. As farmers learn the impact and efficiency of USG on rice production, its use will be encouraged many folds. As the technology is good and financially sound, the nation will reap the benefits of USG technology in the long run.

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