

Effect of Different Organic And Inorganic Fertilizers on the Growth and Yield of Wetland Rice

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ABSTRACT

Two experiments were conducted at farmer's field of Tukurbazer, Sylhet in Boro season and T. aman season of 2013 in order to test the effect of different organic and inorganic fertilizers on the growth and yield of wetland rice. Eight treatment combinations were tested in T. aman season namely T₁= Control (without fertilizer), T₂= Agro-Sar (Organo-Chemical) (ASOC) @ 750 kg/ha, T₃= STB (Soil Test Based), T₄= T₂+50% STB, T₅= T₂ + 60% STB, T₆= T₂ + 70% STB, T₇= T₂ + 80% STB and T₈= T₂ + T₃ where BRRI dhan31 was used as test crop. In Boro season, the following ten treatment combinations were tested in Boro season: namely T₁= FRG '05 dose: N, P, K, S and Zn @ 123, 26, 60, 13 & 4 kg/ha, T₂= Agro meal plus @ 300 kg/ha, T₃= T₂ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₄= ASO @ 740 kg/ha, T₅= T₄ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₆= Agro-Sar (Organo-chemical) (ASOC) @ 740 kg/ha, T₇= T₆ + N, P, K, S @ 74, 18, 36 and 8, T₈= Raj Jaibo Sar @ 790 kg/ha, T₉= T₈ + N, P, K, S @ 74, 20, 54 and 9 kg/ha, and T₁₀= Control (without fertilizer). The blanket doses of fertilizers were applied as soil test based (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, TSP, MP and gypsum. 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: Agro-Sar (Organo-Chemical), Fertilizers, Growth and yield parameters, Wetland rice. Rice seasons, Economic analysis.

INTRODUCTION

Bangladesh is densely populated and agriculture based country. Agriculture is the main source of livelihood for more than 80% of the country's population. Rice is the staple food crop of the people of Bangladesh covering an area of about 64.52 million hectares, producing about 28.93 million metric tons where the average production is about 2.23 t ha⁻¹[1]. Like other crops, the yield level of rice is very low (2.23 t ha⁻¹) compared to other rice growing developed countries like South Korea and Japan where the average yield is 6.00 and 5.22 t ha⁻¹, respectively [3]. Organic matter content of the soils are constantly lessening by repeated farming which leads to hard soil. Nutrient rich organic fertilizer improves soil condition; reduce soil compactness, clotting and erosion. Suitable organic sources of nutrients are necessary for sustainable agriculture that will provide maximum rice production with good quality and maintain a sound environment. Organic matter is the vital component of soil health as well as crop production. Most of the cultivated soil in Bangladesh, organic matter is very low ranging from 0.5-2 % where majority of the cultivated soils is about 1 %. Agro-Sar (Organo-Chemical) is a nutrient enriched mixed fertilizer. The

performance of this fertilizer alongwith other fertilizer combinations was evaluated in Boro and T. aman rice at farmer's field of Tukurbazer, Sylhet in 2013.

MATERIALS AND METHODS

The experiments were conducted at farmer's field of Tukurbazer, Sylhet in Boro season and T. aman season of 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 [2,5-8]. For T. Aman season, the following eight treatment combinations were tested viz. T₁= Control (without fertilizer), T₂= Agro-Sar (Organo-Chemical) (ASOC) @ 750 kg/ha, T₃= STB (Soil Test Based), T₄= T₂+50% STB, T₅= T₂ + 60% STB, T₆= T₂ + 70% STB, T₇= T₂ + 80% STB and T₈= T₂ + T₃. The experiment was laid out in a randomized complete block design with three replications having unit plot size of 5m x 4 m. Fertilizer doses of STB were 93 kg N, 16 kg P, 20 kg K and 10 kg S/ha, and was applied as Urea, TSP, MP and Gypsum, respectively. BRRI dhan 31 was used as test crop. Thirty day old seedlings where 2-3

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seedling/hill were transplanted maintaining 20 cm x 20 cm spacing.

For Boro season, the following ten treatment combinations were tested: which are T₁= FRG '05 dose: N, P, K, S and Zn @ 123, 26, 60, 13 & 4 kg/ha,

required. At maturity, the crop was harvested from 5 m² area for grain and straw yield and grain yield was adjusted to 14% moisture content. The plant height, number of tiller, number of panicle, filled and unfilled grain per panicle and grain & straw yield

Table 1. Initial soil characteristics of the experimental site of Tukurbazer, Sylhet

Parameters	Soil properties
Texture	Sandy loam
pH (1:2.5)	5.79
Organic C (%)	0.80 (Low)
Total N (%)	0.08 (Very low)
Available P(ppm)	8.6 (low)
Exchangeable K(meq/100g soil)	0.22 (Medium)
Available S (ppm)	6.22 (low)
Available Zn(ppm)	1.5 (high)

Table 2. Effect of organic and inorganic fertilizers on the growth and yield of T. Aman rice

Treatment*	Plant height(cm)	Tiller no./m ²	Panicle. no./m ²	Sterility (%)	1000 grain wt.	Grain Yield(t/ha)	Straw Yield (t/ha)
T1	94	173	159	32	26.3	3.10	3.19
T2	100	202	184	30	26.8	3.54	3.95
T3	105	198	185	36	26.3	3.55	4.05
T4	101	194	178	32	27.0	3.70	3.94
T5	103	186	178	36	26.8	3.77	4.07
T6	105	209	188	31	26.8	3.69	3.99
T7	106	236	218	32	26.9	3.70	4.65
T8	109	214	197	28	26.8	3.48	4.32
LSD (5%)	3.5	40	30	6	1.2	0.37	0.79

* T₁= Control (Without fertilizer), T₂= Agro-Sar (Organo-Chemical) (ASOC) @ 750 kg/ha, T₃= STB (Soil Test Based), T₄= T₂+50% STB, T₅= T₂ + 60% STB, T₆= T₂ + 70% STB, T₇= T₂ + 80% STB and T₈= T₂ + T₃.

T₂= Agro meal plus @ 300 kg/ha, T₃= T₂ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₄= ASO @ 740 kg/ha, T₅= T₄ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₆= Agro-Sar (Organo-chemical) (ASOC) @ 740 kg/ha, T₇= T₆ + N, P, K, S @ 74, 18, 36 and 8, T₈= Raj Jaibo Sar @ 790 kg/ha, T₉= T₈ + N, P, K, S @ 74, 20, 54 and 9 kg/ha, and T₁₀= Control (without fertilizer). The experiment was laid out in a randomized complete block design with three replications using unit plot size of 5 m x 4 m. BRRI dhan29 was used as test crop. Fifty day old seedling where 2-3 seedling/hill were transplanted maintaining 20 cm x 20 cm spacing. Fertilizers TSP, MP, Gypsum, and Agro-Sar (Organo-chemical) were applied at final land preparation in the both experiments. Urea was applied into three equal splits like 1/3 basal, 1/3rd maximum tillering stage and the remaining 1/3rd at panicle initiation stage. Intercultural operations were done when it was

were recorded. The data were analyzed following randomized complete block design and mean separation was done by DMRT^[4]. Finally, economic analyses were done for net benefit and marginal rate of return.

RESULTS AND DISCUSSION

Growth and Yield

T. Aman season:

Application of Agro-Sar (Organo-Chemical) alone or in combination with chemical fertilizer increased the plant height of rice over control. Highest plant height (109 cm) was found in treatment T₈ followed by treatment T₇ (106 cm) Application of chemical fertilizer on STB alone or in combination with ASOC did not statistically increase the tiller and panicle number of rice over control. Maximum number of tiller (236) was recorded in treatment T₇

followed by treatment T₈ (214). On the other hand treatment T₇ produced the highest number of panicle. (218) followed by T₈ (197) (Table 2). Minimum number of unfilled grain (28 %) was observed in treatment T₈ followed by T₂. Application of ASOC alone or in combination with chemical fertilizer on STB significantly increased the grain yield of rice over control. Maximum grain yield (3.77 t/ha) was recorded in treatment T₅ followed by treatment T₄ and T₇. Highest straw yield (4.65 t/ha) was found in treatment T₇ followed by treatment T₅.

It is found from the results that 40 to 50% reduction of chemical fertilizer along with ASOC @ 750 kg/ha may be a good combination of organic and inorganic

plus @ 300 kg/ha) was at par with other organic based treatments where supplemented reduced amount of chemical fertilizers. It was found from the Table 3 that the grain yield was significantly affected by different treatments. The highest grain yield (7.41 t/ha) was obtained in treatment T₅ followed by treatment T₉, T₃ and T₇ (which was statistically similar with T₅). In contrast, the lowest grain yield (3.53 t/ha) was found in the treatment T₁₀ (control). It was observed that grain yield was higher in the treatments where chemical fertilizers were applied along with organic fertilizers. Application of organic fertilizers could not produce comparable yield with the FRG '05 dose (T₁), indicated that the higher yield

Table 3. Effect of organic and inorganic fertilizers on the growth and yield of Boro rice

Treatment*	Panicle/m ²	% Sterility	1000 grain weight(gm).	Grain Yield (t/ha)	Straw Yield (t/ha)
T1	303	19	22	6.70	7.60
T2	237	20	20	4.34	5.34
T3	307	20	22	6.92	7.92
T4	242	16	20	4.65	5.65
T5	324	22	22	7.41	8.41
T6	225	17	21	4.22	5.22
T7	306	19	22	6.77	7.77
T8	227	17	21	4.47	5.47
T9	323	17	22	7.20	8.20
T10	194	21	20	3.53	4.58
LSD (5%)	58	4	0.78	0.47	0.56

*T₁= FRG '05 dose: N, P, K, S and Zn @ 123, 26, 60, 13 & 4 kg/ha, T₂= Agro meal plus @ 300 kg/ha, T₃= T₂ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₄= ASO @ 740 kg/ha, T₅= T₄ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₆= Agro-Sar (Organo-chemical) (ASOC) @ 740 kg/ha, T₇= T₆ + N, P, K, S @ 74, 18, 36 and 8, T₈= Raj Jaibo Sar @ 790 kg/ha, T₉= T₈ + N, P, K, S @ 74, 20, 54 and 9 kg/ha, and T₁₀=Control(Without fertilizer).

fertilizer for producing reasonable higher yield.

Boro season:

Different organic and organo-chemical/chemical fertilizers had significant role in production of panicle/m² (Table 3). Panicle production per unit area was statistically higher in the treatments where chemical fertilizers applied along with organic fertilizer compared to the treatments where only organic fertilizer applied. The lowest panicle per unit area (194) was observed in treatment T₁₀ (Control) which was about 20% less than the organic based treatments. However, panicle/m² in T₂ (Agro meal

can only be achieved when organic fertilizers and chemical fertilizers are applied together.

Economic analysis:

Net benefit

Economic analysis on partial budget of the experiments is presented in Table 4 & 5. The net benefit of each treatment is calculated by subtracting the total costs that vary from the gross field benefit. The total costs are the sum of all the costs that vary for a particular treatment. The maximum net benefit (88 %) was achieved in treatment T₅ followed by T₃

Table 4. Economic analysis of partial budget against different treatments of T.Aman rice

Particulars	<i>Treatments</i>							
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈
Grain yield (t/ha)	3.1	3.54	3.55	3.7	3.77	3.69	3.7	3.48
Straw yield (t/ha)	3.19	3.95	4.05	3.94	4.07	3.99	4.65	4.32
Adjusted grain yield (t/ha)	2.79	3.19	3.20	3.33	3.39	3.32	3.33	3.13
Adjusted straw yield (t/ha)	2.87	3.56	3.65	3.55	3.66	3.59	4.19	3.89
Gross field benefit, grain (Tk/ha)	27900	31860	31950	33300	33930	33210	33300	31320
Gross field benefit, straw (Tk/ha)	5742	7110	7290	7092	7326	7182	8370	7776
Total gross field benefit (Tk/ha)	33642	38970	39240	40392	41256	40392	41670	39096
Total gross field cost (Tk/ha)	0	3188	2970	4673	4970	5267	5564	6158
Net benefit (Tk/ha)	33642	35783	36270	35720	36287	35126	36107	32939

Urea = Tk. 20.00 /kg, TSP= Tk 26.00/kg, MP= Tk.25.00./kg , Gypsum= Tk. 10.00/kg, Agro-Sar (Organo-Chemical)=Tk 12.00/kg, Paddy= Tk.20.00/kg and straw= Tk. 3.00 /kg, As the requirement of the model the grain and straw yield was adjustment @ 10% reduced level and Minimum rate of return = 100%

(T. Aman season). The highest net benefit was found in T₅ followed by T₃ (Boro season).

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 consideration. As the increase in cost, the net benefit would be

increased but the net benefits are lower in T₂, T₄, T₆, T₇ and T₈ as the cost increased. Thus, T₂, T₄, T₆, T₇ and T₈ are cost dominated treatments and can be eliminated for further consideration (Table 6, T. Aman season). Similarly, T₁, T₆, T₇, T₈ and T₉ treatment are cost dominated treatment and can be eliminated for further consideration (Table 7, Boro season). 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 was recorded between T₁ and T₃ is 88%. It is indicated that farmers will continue to invest as long

indicate 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 7). Thus, it can be concluded that T₄ is the most economically viable treatment of the experiment.

CONCLUSION

In T. Aman season, STB fertilization appeared to be the economically most viable treatment although the treatment T₄ and T₅ that produced higher yield than that of STB. In Boro season, treatment T₇ where ASOC applied along with reduced rate of chemical fertilizer produced substantially higher yield. Integrated use of organic and inorganic fertilizer is essential for sustainable increased crop production and improved soil fertility. In addition, reduced use of chemical fertilizer may positively influences the environment through reducing contamination of air,

Table 5. Economic analysis of partial budget against different treatments of Boro rice

Particulars	Treatments									
	T ₁	T ₂	T ₃	T ₄	T ₅	T ₆	T ₇	T ₈	T ₉	T ₁₀
Grain yield (t/ha)	6.7	4.34	6.92	4.65	7.41	4.22	6.77	4.47	7.2	3.53
Straw yield (t/ha)	7.6	5.34	7.92	5.65	8.41	5.22	7.77	5.47	8.2	4.58
Adjusted grain yield (t/ha)	6.03	3.91	6.23	4.19	6.67	3.80	6.09	4.02	6.48	3.18
Adjusted straw yield (t/ha)	6.84	4.81	7.13	5.09	7.57	4.70	6.99	4.92	7.38	4.12
Gross field benefit, grain (Tk/ha)	4824	3124	4982	3348	5335	3038	4874	3218	5184	2541
Gross field benefit, straw (Tk/ha)	0	8	4	0	2	4	4	4	0	6
Total gross field benefit (Tk/ha)	6840	4806	7128	5085	7569	4698	6993	4923	7380	4122
Total gross field cost (Tk/ha)	5508	3605	5695	3856	6092	3508	5573	3710	5922	2953
Net benefit (Tk/ha)	0	4	2	5	1	2	7	7	0	8
	4992	3485	5317	3560	5486	3212	4935	3394	5222	2953
	0	4	2	5	5	2	5	7	4	8

Urea = Tk. 20.00 /kg, TSP= Tk 26.00/kg, MP= Tk.25.00./kg , Gypsum= Tk. 10.00/kg,

Agro-Sar (Organo-chemical) =Tk 12.00/kg, Paddy= Tk 20.00/kg and straw= Tk. 3.00 /kg, As the requirement of the model the grain and straw yield was adjustment @ 10% reduced level and Minimum rate of return = 100%

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). Thus, it can be concluded that T₃ is the most economically viable treatment of the experiment (T. Aman). For Boro season, the maximum marginal rate of return between T₄ and T₃ is 2142% well above the 100% minimum. That

soil and water. Considering these points, it may be suggested that 40 to 50% reduction of chemical fertilizer on STB along with ASOC @ 750 kg/ha may be a good combination of organic and inorganic fertilizer for sustaining soil fertility and increasing T. aman and Boro rice.

Table 6. Dominance and marginal analysis on growth and yield against different treatments of T. Aman rice

Treatments*	Total costs that vary (Tk./ha)	Net benefit (Tk./ha)	Marginal rate of return (%)
T1	0	33642	
T3	2970	36270	
T2	3188	35783 D	
T4	4673	35720 D	
T5	4970	36287	
T6	5267	35126 D	
T7	5564	36107 D	
T8	6158	32939 D	

D=Dominated;*T₁= Control, T₂= Agro-Sar (Organo-Chemical) (ASOC) @ 750 kg/ha, T₃= STB (Soil Test Based), T₄= T₂+50% STB, T₅= T₂ + 60% STB, T₆= T₂ + 70% STB, T₇= T₂ + 80% STB and T₈= T₂ + T₃.

Table 7. Dominance and marginal analysis on growth and yield against different treatments of Boro rice

Treatments*	Total costs that vary (Tk./ha)	Net benefit (Tk./ha)	Marginal rate of return (%)
T10	0	29538	
T2	1200	34854	
T6	2960	32122 D	
T4	2960	35605	
T8	3160	33947 D	
T3	3780	53172	
T1	5160	49920 D	
T5	6056	54865	
T7	6382	49355 D	
T9	6996	52224 D	

D=Dominated;*T₁= FRG '05 dose: N, P, K, S and Zn @ 123, 26, 60, 13 & 4 kg/ha, T₂= Agro meal plus @ 300 kg/ha, T₃= T₂ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₄= ASO @ 740 kg/ha, T₅= T₄ + N, P, K, S @ 74, 16, 60 and 8 kg/ha, T₆= Agro-Sar (Organo-chemical) (ASOC) @ 740 kg/ha, T₇= T₆ + N, P, K, S @ 74, 18, 36 and 8, T₈= Raj Jaibo Sar @ 790 kg/ha, T₉= T₈ + N, P, K, S @ 74, 20, 54 and 9 kg/ha, and T₁₀= Control (Without fertilizer).

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