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INTEGRATED EFFECT OF DIFFERENT ORGANIC MANURES AND INORGANIC FERTILIZERS ON THE GROWTH AND YIELD OF WETLAND RICE

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Abstract

Two experiments were conducted at farmers' field, Tukerbazer, Sylhet during T. aman season 2011 and Boro season 2012 in order to test the integrated effect of different organic manures and inorganic fertilizers on the growth and yield of wetland rice. In T. aman season eight treatments combinations were: T_1= Control, T_2= Agro-Sar Organic (ASO) @ 750 kg ha^{-1}, T_3= Soil Test Based (STB), T_4= T_2+50% STB, T_5= T_2 + 60% STB, T_6= T_2 + 70% STB, T_7= T_2 + 80% STB and T_8= T_2 + T_3. BRRI dhan31 was used as test crop. In Boro season ten treatments combinations were: T_1= Fertilizer Recommendation Guide 2005 dose: NPKSZn @ 123, 26, 60, 13 and 4 kg ha^{-1}, T_2= Agro meal plus @ 300 kg ha^{-1}, T_3= T_2 + NPKS @ 74, 16, 60 and 8 kg ha^{-1}, T_4= ASO @ 740 kg ha^{-1}, T_5= T_4 + NP KS @ 74, 16, 60 and 8 kg ha^{-1}, T_6= Agro-Sar (ASOC) @ 740 kg ha^{-1}, T_7= T_6 + NPKS @ 74, 18, 36 and 8, T_8= Raj Jaibo Sar @ 790 kg ha^{-1}, T_9 = T_8 + NPKS @ 74, 20, 54 and 9 kg ha^{-1}, and T_{10}= Control (No fertilizer). BRRI dhan29 was used as test crop. The experiments were laid out in a Randomized Complete Block Design with 3 replications. In T. aman season maximum grain yield (3.87 t ha^{-1}) was recorded in treatment T_7 (ASO @ 750 kg ha^{-1} + 80% STB). In Boro season highest grain yield (7.41 t ha^{-1}) was obtained in treatment T_5 (ASO @ 740 kg ha^{-1} + NPKS @ 74, 16, 60 and 8 kg ha^{-1}). The organic fertilizer ASO @ 750 kg ha^{-1} in combination with 50% reduced rate of chemical fertilizer on STB at T. Aman season and ASO @ 740 kg ha^{-1} in combination with 50% reduced rate of chemical fertilizer on FRG'05 dose at Boro season produced substantially higher yield.

Keywords: AGRO-SAR, Raj jaibo sar, wetland rice, growth, yield

Introduction

Continuous use of inorganic fertilizers alone to soils had a deleterious effect on soil productivity and a steadily trend in rice productivity associated mainly with loss of inherent soil fertility (Nambiar, 1998). Organic matter content of the soils are constantly lessening by repeated farming which leads to soil harder. 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. Agro-Sar is a nutrient enriched organic fertilizer. Targeting high yield with a high cropping intensity is the most logical way to raise the total production from the country's limited land resources. Since the nutrient turnover in soil plant system is considerably high in intensive farming, neither the chemical fertilizers nor the organic and biological sources alone can achieve production sustainability. Even with balanced use of chemical fertilizers high yield level could not be maintained over the years because of deterioration in soil physical and biological environments due to low organic matter content in soils. In this context and as a further response to economic recession, and also to conserve and improve soil fertility, the concept of integrated nutrient management (INM) system has been adopted. The performance of these fertilizers were evaluated at farmers' field of Tukerbazer, Sylhet in T. aman rice 2011 and Boro rice 2012.

Materials and Methods

The experiments were conducted at farmers' field of Tukerbazer, Sylhet in T. aman season 2011 and Boro season 2012. Eight treatment combinations were tested in T. aman season viz. T_1= Control, T_2= Agro-Sar Organic (ASO)

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@ 750 kg ha^{-1}, T_3= STB (Soil Test Based), T_4= T_2+50% STB, T_5= T_2 + 60% STB, T_6= T_2 + 70% STB, T_7= T_2 + 80% STB and T_8= T_2 + T_3. The experiment was laid out in a randomized complete block design with three replications having unit plot size of 4 m × 3 m. Fertilizer doses on STB were 93 kg N, 17 kg P, 36 kg K and 13 kg S ha^{-1} and was applied as urea, TSP, MoP and gypsum, respectively. BRRI dhan31 was used as test crop. Thirty day old 2-3 seedling hill^{-1} were transplanted with 20 cm × 20 cm spacing. Ten treatment combinations were tested in Boro season viz. T_1= Fertilizer Recommendation Guide (FRG) 2005 dose: NPKSZn @ 123, 26, 60, 13 & 4 kg ha^{-1}, T_2= Agro meal plus @ 300 kg ha^{-1}, T_3= T_2 + N, P, K, S @ 74, 16, 60 and 8 kg ha^{-1} , T_4= ASO @ 740 kg ha^{-1}, T_5= T_4 + NPKS @ 74, 16, 60 and 8 kg ha^{-1}, T_6= Agro-Sar (Organo-chemical) (ASOC) @ 740 kg ha^{-1}, T_7= T_6 + NPKS @ 74, 18, 36 and 8, T_8= Raj Jaibo Sar @ 790 kg ha^{-1}, T_9 = T_8 + NPKS @ 74, 20, 54 and 9 kg ha^{-1}, and T_{10}= Control (No fertilizer). Raj Jaibo Sar is a organic fertilizer. The experiment was laid out in a randomized complete block design with three replications having unit plot size of 5 m × 4 m. BRRI dhan29 was used as test crop. Forty days old 2-3 seedling hill^{-1} were transplanted with 20 cm × 20 cm spacing. 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). For both experiments TSP, MoP, Gypsum, and Agro-Sar were applied at final land preparation. 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 no., panicle no., sterile spikelet and filled grain production, grain and straw yield were recorded. Finally economic analyses were done for net benefit and marginal rate of return.

Table 1. Initial soil characteristics of the experimental site

Parameters	Result/value
Texture	Sandy loam
pH (1:2.5)	5.85
Organic C (%)	0.80 (Low)
Total N (%)	0.08 (Very low)
Available P (ppm)	7.12 (Low)
Exchangeable K (meq/100g soil)	0.15 (Medium)
Available S (ppm)	6.22 (Very low)
Available Zn (ppm)	1.5 (High)

Results and Discussion

Growth and Yield

Integrated effect of organic and inorganic fertilizers on the growth and yield of T. aman rice

Application of Agro-Sar (ASO) alone or in combination with chemical fertilizer did not statistically increase the plant height and panicle number of rice over control. The highest plant height was found in treatment T_8 (ASO @ 750 kg ha^{-1} + STB) followed by T_3 (STB) and T_7 (ASO @ 750 kg ha^{-1} + 80% STB). On the other hand, treatment T_3 (Soil Test Based) produced the highest number of panicles followed by T_7 (ASO @ 750 kg ha^{-1} + 80% STB). Application of chemical fertilizer on STB alone or in combination with ASO increased the tiller no. of rice over control. The highest number of tiller was recorded in treatment T_7 (ASO @ 750 kg ha^{-1} + 80% STB) followed by treatment T_3 (Soil Test Based) and T_5 (ASO @ 750 kg ha^{-1} + 60% STB) (Table 2). The lowest number of sterile spikelet was observed in treatment T_8 (ASO @ 750 kg ha^{-1} + STB) followed by T_2 (ASO @ 750 kg ha^{-1}). Chemical fertilization on STB alone or in combination with ASO produced identical and substantially higher grain and straw yield of rice than those of control and lone application of ASO. The highest grain yield was recorded in treatment T_7 (ASO @ 750 kg ha^{-1} + 80% STB) followed by treatment T_4 (ASO @ 750 kg ha^{-1} + 50% STB). It is observed from the results that 50% reduction of chemical fertilizer along with ASO @ 750 kg ha^{-1} may be a good combination of organic and inorganic fertilizer for producing reasonable higher yield of transplanted Aman rice.

Integrated effect of organic and inorganic fertilizers on the growth and yield of Boro rice

Different organic and chemical fertilizers had significant role in production of panicle m^{-2} (Table 3). Panicle production per unit area was statistically higher in the treatments where chemical fertilizers applied along with organic fertilizer than in the treatments where only organic fertilizer applied. Combination of chemical and organic fertilizers have positive role in enhanced panicle production per unit area. The lowest number of panicle per unit area was observed in treatment T_{10} (Control) which was 20% less than the organic – inorganic combined treatments.

However, panicle m^{-2} in T_2 (Agro meal plus @ 300 kg ha^{-1}) was at par with other organic based treatments where supplemented reduced amount of chemical fertilizers. Grain yield was significantly affected by different treatments (Table 3). The highest grain yield was obtained in treatment T_5 (ASO @ 740 kg ha^{-1} + NPKS @ 74, 16, 60 and 8 kg ha^{-1}) followed by treatment T_9 (Raj Jaibo Sar @ 790 kg ha^{-1} + NPKS @ 74, 20, 54 and 9 kg ha^{-1}), T_3 (Agro meal plus @ 300 kg ha^{-1} + NPKS @ 74, 16, 60 and 8 kg ha^{-1}) and T_7 (Agro-Sar, Organo-chemical) @ 740 kg ha^{-1} + NPKS @ 74, 18, 36 and 8) which was statistically similar with T_5. In contrast, the lowest grain yield was found in the treatment T_{10} (control). It was observed that grain yield was higher in the treatments where chemical fertilizers were applied along with organic manures. Application of only organic manures could not produce comparable yield with the FRG '05 dose (T_1) indicated that higher yield can only be achieved when organic and inorganic fertilizers are applied in combination.

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

Treatment	Plant height (cm)	Till. m^{-2} (no.)	Panicles m^{-2} (no.)	% Sterility	1000-grain wt.(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1	96	165	142	30	25.8	2.77	3.00
T_2	97	168	143	29	25.9	2.89	3.12
T_3	104	205	185	30	26.5	3.49	4.40
T_4	100	198	174	32	26.7	3.81	4.13
T_5	101	205	174	34	26.3	3.66	4.31
T_6	103	194	166	31	26.3	3.58	3.94
T_7	104	213	183	32	26.8	3.87	4.41
T_8	107	200	178	28	26.5	3.69	4.09
LSD (5%)	7	27	56	5	0.71	0.48	0.59

T_1= Control, T_2= Agro-Sar Organic (ASO) @ 750 kg ha^{-1}, T_3= Soil Test Based (STB), T_4= T_2+50% STB, T_5= T_2 + 60% STB, T_6= T_2 + 70% STB, T_7= T_2 + 80% STB and T_8= T_2 + T_3

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

Treatment	Panicle m^{-2} (no.)	% Sterility	1000-grain wt.(g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1	303	19	22	6.7	7.6
T_2	237	20	20	4.34	5.34
T_3	307	20	22	6.92	7.92
T_4	242	16	20	4.65	5.65
T_5	324	22	22	7.41	8.41
T_6	225	17	21	4.22	5.22
T_7	306	19	22	6.77	7.77
T_8	227	17	21	4.47	5.47
T_9	323	17	22	7.2	8.2
T_{10}	194	21	20	3.53	4.58

T_1= FRG '05 dose: NPKSZn @ 123, 26, 60, 13 & 4 kg ha^{-1}, T_2= Agro meal plus @ 300 kg ha^{-1}, T_3= T_2 + NPKS @ 74, 16, 60 and 8 kg ha^{-1}, T_4= ASO @ 740 kg ha^{-1}, T_5= T_4 + NPKS @ 74, 16, 60 and 8 kg ha^{-1}, T_6= Agro-Sar (Organo-chemical) (ASOC) @ 740 kg ha^{-1}, T_7= T_6 + NPKS @ 74, 18, 36 and 8, T_8= Raj Jaibo Sar @ 790 kg ha^{-1}, T_9 = T_8 + N PKS@ 74, 20, 54 and 9 kg ha^{-1}, and T_{10}= Control (No-fertilizer).

Table 4. Effect of organic and inorganic fertilizers on the partial budget for T. Aman rice cultivation

Treatment	Gross return (Tk ha^{-1})	Cost of cultivation (Tk ha^{-1})	Net return (Tk ha^{-1})
T_1	30330	0	30330
T_2	31626	3000	28626
T_3	39330	3427	35903
T_4	41724	4713	37011
T_5	40698	5056	35642
T_6	39312	5399	33913
T_7	42768	5741	37027
T_8	6427	6427	34145

Urea=Tk. 20.00 kg^{-1}, TSP= Tk 26.00 kg^{-1}, MoP= Tk. 25.00 kg^{-1}, Gypsum= Tk. 10.00 kg^{-1}, Agro-Sar =Tk 10.00 kg^{-1}, Paddy= Tk 20.00 kg^{-1} and straw= Tk. 3.00 kg^{-1}.

Economic analysis

Net return

Economic analyses on partial budget of the experiments are presented in Table 4 and 5. The net return of each treatment is calculated by subtracting the total costs which vary from the gross field return. The total costs that vary are the sum of all the costs that vary for a particular treatment. The highest net return benefit was achieved in treatment T_7 followed by T_4 in T. Aman season. The highest net return was found in T_5 followed by T_3 in Boro season.

Table 5. Effect of organic and inorganic fertilizers on the partial budget for Boro rice cultivation

Treatment	Gross return (Tk ha^{-1})	Cost of cultivation (Tk ha^{-1})	Net return (Tk ha^{-1})
T_1	55080	5160	49920
T_2	36054	1200	34854
T_3	56952	3780	53172
T_4	38565	2960	35605
T_5	60921	6056	54865
T_6	35082	2960	32122
T_7	55737	6382	49355
T_8	37107	3160	33947
T_9	59220	6996	52224
T_{10}	29538	0	29538

Urea=Tk. 20.00 kg^{-1}, TSP= Tk 26.00 kg^{-1}, MoP= Tk. 25.00 kg^{-1}, Gypsum= Tk. 10.00 kg^{-1}, Agro-Sar =Tk 10.00 kg^{-1}, Paddy= Tk 20.00 kg^{-1} and Straw= Tk. 3.00 kg^{-1}.

Table 6. Dominance and marginal analysis for T. Aman rice production

Treatments	Total costs that vary (Tk ha^{-1})	Net return (Tk ha^{-1})	Marginal rate of return (%)
T_1	0	30330	
T_2	3000	28626	1704
T_3	3427	35903	
T_4	4713	37011	86
T_5	5056	35642 D	
T_6	5399	33913 D	1.5
T_7	5741	37027	
T_8	6427	34145 D	

D=Dominated; T_1= Control, T_2= Agro-Sar Organic (ASO) @ 750 kg ha^{-1}, T_3= Soil Test Based (STB), T_4= T_2+50% STB, T_5= T_2 + 60% STB, T_6= T_2 + 70% STB, T_7= T_2 + 80% STB and T_8= T_2 + T_3.

Table 7. Dominance and marginal analysis for Boro rice production

Treatments	Total costs that vary (Tk ha^{-1})	Net return (Tk ha^{-1})	Marginal rate of return (%)
T_{10}	0	29538	
T_2	1200	34854	443
T_6	2960	32122 D	
T_4	2960	35605	43
T_8	3160	33947 D	
T_3	3780	53172	2142
T_1	5160	49920 D	
T_5	6056	54865	74
T_7	6382	49355 D	
T_9	6996	52224 D	

D=Dominated; T_1= FRG '05 dose: NPKSZn @ 123, 26, 60, 13 & 4 kg ha^{-1}, T_2= Agro meal plus @ 300 kg ha^{-1}, T_3= T_2 + NPKS @ 74, 16, 60 and 8 kg ha^{-1}, T_4= ASO @ 740 kg ha^{-1}, T_5= T_4 + NPKS @ 74, 16, 60 and 8 kg ha^{-1}, T_6= Agro-Sar (Organo-chemical) (ASOC) @ 740 kg ha^{-1}, T_7= T_6 + NPKS @ 74, 18, 36 and 8, T_8= Raj Jaibo Sar @ 790 kg ha^{-1}, T_9 = T_8 + NPKS @ 74, 20, 54 and 9 kg ha^{-1}, and T_{10}= Control (No fertilizer).

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 return would be increased. But the net returns are lower in T_5, T_6 and T_8 as the cost increase. Thus in T. aman season T_5, T_6 and T_8 are cost dominated treatment and can be

eliminated (Table 6). Similarly, in Boro season T_1, T_6, T_7, T_8 and T_9 treatment were cost dominated treatment and can be eliminated (Table 7).

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.

For T. Aman season, the maximum marginal rate of return between T_2 and T_3 is 1704% 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). Thus it can be concluded that T_3 is the most economically viable treatment of the experiment. For Boro season, the maximum marginal rate of return between T_4 and T_3 is 2142% 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 7). Thus it can be concluded that T_4 is the most economically viable treatment of the experiment.

The organic fertilizer ASO @ 750 kg ha^{-1} in combination with 50% reduced rate of chemical fertilizer on STB at T. Aman season and ASO @ 740 kg ha^{-1} in combination with 50% reduced rate of chemical fertilizer on FRG'05 dose at Boro season produced substantially higher yield. Integrated use of organic and inorganic fertilizer is the need of time for sustainable increased crop production and improved soil fertility. Considering these points it is suggested that 50% reduction of chemical fertilizer on STB and FRG'05 dose along with ASO @750 kg ha^{-1} may be a good combination for sustaining soil fertility and increasing the yield of T. aman rice and Boro rice.

References

Black C A. 1965. Methods of soil analysis. Part I and II. Amer. Soc. Agron. Inc. Pub., Madison. USA.

Jackson M L. 1962. Soil Chemical Analysis. Constable and Co. Ltd. London.

Nambiar K K M. 1998. Major cropping system in India. In: Agricultural Sustainability: Economics Environmental and Statistical Considerations (Eds. V. Barmett *et al.*). John Wiley & Sons, Chichester, U.K. pp.133-139.

Olsen S R, Cole C V, Watanable F S and Dean L A.1954. Estimation of available phosphorus in soils by extraction with sodium carbonate U.S. Dept. Agr. (Circ.) pp.929.

Page A L, Miller R H and Keeney D R. 1982. Methods of Soil Analysis Part 2. 2nd Ed. Am. Soc. Agron. Increased. Madison. Wisconsin, USA.

Walkley A and Black A I. 1935. An examination of the Degtijaref method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Sci., 37:29-38.