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EVALUATION OF MIXED AND COMPLEX FERTILIZERS FOR WETLAND RICE

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Three grades of mixed/complex fertilizers were field tested in wetland rice culture at Bangladesh Rice Research Institute (BRRI) farm during dry and wet seasons of the year 1992 using randomized complete block design with a view to evaluate their effectiveness against straight fertilizers. Test varieties were BR3 and BR11 for dry and wet seasons, respectively. Results implied that mixed/complex fertilizers were equally effective as straight fertilizers in increasing grain yield of rice. Mineral nutrition of and nutrient removal by rice plants were also almost similar irrespective of fertilizer sources.

Key words. Mixed/complex fertilizer, Straight fertilizer, Rice.

Introduction

Rice is the major food crop in South-East Asian countries including Bangladesh. Rice plant requires large amount of mineral nutrients like N, P, K, S etc. for its growth, development and grain production [1, 2]. Continuous rice cropping and adoption of improved rice varieties with the expansion of irrigation facilities caused increased rice production in recent years. Consequently, the rice soils of this region are being depleted in mineral nutrients like N, P, K, S etc. due to uptake of these nutrients by rice plants. So, balanced fertilization is necessary to meet the crop demand and to maintain soil fertility.

Most of the rice soils of Bangladesh are deficient in nitrogen. Hence, fertilizer N application is essential to meet the crop demand. There is a tendency among the farmers of this country to apply more N fertilizer in comparison with other fertilizers in rice fields because of its sharp response. The ranges of N, P, K fertilizers used at farmers' field of Bangladesh for irrigated rice production are 70–113 kg N/ha, 6–21 kg P/ha and 9–27 kg K/ha [3]. Most of the farmers do not apply S fertilizer. The amounts of N, P, K fertilizers used by the farmers are not in balanced proportion. For balanced fertilization, the researchers' recommended dose of N,P,K,S fertilizer for irrigated rice production is 120-26-35-20 kg N, P, K, S/ha respectively. Apparently, the farmers are getting good yield by applying more N fertilizer in comparison with other fertilizers. But if this practice continues for long time there is a possibility that the rice soils of this country, particularly under intensive culture, will become deficient in other nutrients like P, K, S etc. It is, therefore, imperative to apply balanced fertilizers for maintaining soil fertility and sustaining crop production. For this purpose mixed and complex fertilizers may be good alternatives to straight fertilizers. Now-a-days various mixed/complex fertilizers are available in the market. Before large scale adoption of these materials, field testing is necessary to evaluate their efficiency, advantages and disadvantages relative to straight fertilizers. A study was, therefore, undertaken to evaluate the performance of mixed/complex fertilizers relative to straight ones in wetland rice culture.

Materials and Methods

Two field experiments were conducted at Bangladesh Rice Research Institute (BRRI) farm at Gazipur during 1992 dry season (Jan.-May) and wet season (July-Dec.). The soil of the experimental field was texturally clayey in nature having pH 6.6, organic C 1.26%, total N 0.11%, available P 13 ppm, NH_4OAc extractable, K 113 ppm and available S 7.5 ppm. Analyses of the soil were done following standard procedures [4]. The fertilizer sources used in the trials were: (1) Mixed fertilizer (7.58-14.44-11.53-4.44% N-P_2O_5-K_2O-S, respectively), (2) complex fertilizer (16-16-16% N-P_2O_5-K_2O, respectively), (3) complex fertilizer (23-23%, N-P_2O_5, respectively) and (4) Straight fertilizers [urea: $CO(NH_2)_2$, triple superphosphate: $Ca(H_2PO_4)_2$, muriate of potash: KCl and gypsum: $CaSO_4 \cdot 2H_2O$]. Mixed fertilizer was produced by Chittagong urea factory, Bangladesh. Complex fertilizers were produced in the Netherlands and supplied by a local agent. A single rate of nutrients, N-P-K-S @ 120 – 26 – 38 – 18 kg/ha was applied. Mixed/complex fertilizers were supplemented by straight fertilizers to maintain the mentioned dose. A control (no fertilizer) treatment was also included in the trials. The experiments were laid out in randomized complete block design with 3 replications.

Full dose of P, K and S was applied before transplanting at final land preparation. Nitrogen was applied in 3 equal splits (1/3 basal + 1/3 at active tillering stage + 1/3 at 5-7 days before panicle initiation). In the dry season, 50 day old seedlings of an improved rice variety, BR3 (Biplab), were transplanted on

15 January, 1992 with a spacing of 20 cm x 20 cm. Necessary intercultural operations were done and irrigation was provided as and when required. The crop was harvested at maturity (17 May) for grain and straw yield determination. During the wet season, 30 day old seedlings of an improved rice variety, BR11 (Mukta), were transplanted on 5 August, 1992 in the same field after harvesting the dry season crop. Fertilizer doses and application schedules were same in both the seasons. Necessary intercultural operations similar to the dry season were done. Supplementary irrigation was provided as and when required. The crop was harvested at maturity (29 Nov.) for grain and straw yield determination. In dry season, relatively older seedlings were used in comparison with wet season, because growth rate of rice seedlings was lower in dry season due to low temperature and, consequently, growth duration of the dry season rice (BR3) was longer compared to that of wet season rice (BR11). Grain yield was adjusted to 14% moisture and straw yield was recorded on oven dry basis (dried in oven at 70° for 72 hrs) in both the seasons. Grain and straw samples were analysed for N, P and K concentration following the standard procedures [5]. Sulphur content of the plant samples was also determined following the diacid digestion method [6]. The data were analysed statistically using standard procedures [7].

Results and Discussion

Grain and straw yield increased significantly over control irrespective of fertilizer sources in both dry and wet seasons (Table 1). This was expected as the soil of the experimental field was deficient in N and S. However, there was no significant difference among the fertilizer sources. In the dry season, grain yield of BR3 ranged from 2.1–5.7 t/ha while in wet season, grain yield of BR11 ranged from 2.2–5.7 t/ha. Straw yield of BR3 and BR11 ranged from 2.1 to 5.4 t/ha and 2.6–6.0 t/ha in dry and wet seasons, respectively. Agronomic efficiency (kg grain/kg added nutrient) was statistically similar among the fertilizer sources in both the seasons. In dry season, agronomic efficiency in BR3 ranged from 17.3–17.8 while in wet season, agronomic efficiency in BR11 ranged from 14.9–17.3 (Table 1). The results clearly showed that both mixed and complex fertilizers were equally effective as straight fertilizers in increasing the grain yield of wetland rice. Similar results were found in some previous investigations [8, 9]. Generally, most of the farmers of this region do not apply balanced fertilizers for crop production. If mixed/complex fertilizers are introduced as alternatives to straight fertilizers, they will be imposed to apply fertilizer materials in balanced amount. This will help to maintain soil fertility and sustain crop productivity.

In the dry season, N, P, K and S content in the grain of BR3 ranged from 0.96–1.08, 0.20–0.28, 0.43–0.48 and 0.10–0.15%, respectively while the values for straw ranged from 0.40–0.48, 0.05–0.07, 1.45–1.84 and 0.05–0.07%, respectively (Table 2). During the wet season, N, P. K and S. content in the grain of BR11 ranged from 1.02–1.31, 0.19–0.27, 0.37–0.47 and 0.10–0.16%, respectively (Table 3). On the other hand, N, P, K and S content in the straw of BR11 ranged from 0.40–0.52, 0.05–0.08, 1.40–1.53 and 0.04–0.06%, respectively. Statistical analysis showed that in most of the cases the fertilizer sources were similar with respect to nutrient content in grain and straw. Nutrient concentrations in grain and straw of rice plant, found in this trial, are in agreement with some previous findings [10–12].

Total uptake of N, P, K and S increased significantly over control due to fertilizer application irrespective of fertilizer sources in both the seasons (Table 4). This was attributed to

TABLE 1. EFFECT OF FERTILIZER SOURCES ON YIELD PERFORMANCE OF WETLAND RICE.

Fertilizer source	Dry season 1992 (BR3)			Wet season 1992 (BR11)		
	Grain yield (t/ha)	Straw yield (t/ha)	Agronomic efficiency (kg grain/kg added nutrient)	Grain yield (t/ha)	Straw yield (t/ha)	Agronomic efficiency (kg grain/kg added nutrient)
Mixed fertilizer (7.58–14.44–11.53–4.44)	5.6	5.3	17.3	5.2	6.0	14.9
Complex fertilizer (16–16–16)	5.6	5.0	17.3	5.5	5.8	16.3
Complex fertilizer (23–23)	5.6	5.1	17.3	5.7	6.0	17.3
Straight fertilizers (Urea, TSP, MP and gypsum)	5.7	5.4	17.8	5.4	5.9	15.8
No fertilizer (control)	2.1	2.1	–	2.2	2.6	–
LSD (0.05)	0.46	1.50	2.21	0.76	0.35	3.71

TABLE 2. EFFECT OF FERTILIZER SOURCES ON N, P, K AND S NUTRITION OF BR3 (DRY SEASON, 1992).

Fertilizer source	Nutrient content (%) in grain				Nutrient content (%) in straw			
	N	P	K	S	N	P	K	S
Mixed fertilizer (7.58-14.44-11.53-4.44)	1.00	0.28	0.46	0.15	0.42	0.06	1.72	0.07
Complex fertilizer (16-16-16)	1.08	0.26	0.48	0.14	0.48	0.06	1.65	0.06
Complex fertilizer (23-23)	0.99	0.25	0.47	0.12	0.47	0.07	1.84	0.06
Straight fertilizer (Urea, TSP, MP and gypsum)	0.98	0.26	0.47	0.12	0.42	0.07	1.68	0.06
No fertilizer (control)	0.96	0.20	0.43	0.10	0.40	0.05	1.45	0.05
LSD (0.05)	0.04	0.02	0.04	0.02	0.05	0.02	0.05	0.02

TABLE 3. EFFECT OF FERTILIZER SOURCES ON N, P, K AND S NUTRITION OF BR11 (WET SEASON, 1992).

Fertilizer source	Nutrient content (%) in grain				Nutrient content (%) in straw			
	N	P	K	S	N	P	K	S
Mixed fertilizer (7.58-14.44-11.53-4.44)	1.21	0.23	0.47	0.14	0.48	0.06	1.53	0.05
Complex fertilizer (16-16-16)	1.20	0.25	0.40	0.13	0.42	0.08	1.47	0.06
Complex fertilizer (23-23)	1.10	0.27	0.41	0.16	0.44	0.07	1.45	0.06
Straight fertilizer (Urea, TSP, MP and gypsum)	1.31	0.24	0.42	0.13	0.52	0.06	1.50	0.05
No fertilizer (control)	1.02	0.19	0.37	0.10	0.40	0.05	1.40	0.04
LSD (0.05)	0.05	0.04	0.04	0.02	0.05	0.02	0.06	0.01

TABLE 4. EFFECT OF FERTILIZER SOURCES ON N, P, K AND S UPTAKE BY RICE.

Fertilizer source	Nutrient uptake (kg/ha) by rice (grain and straw)							
	BR3 (dry season, 1992)				BR11 (wet season, 1992)			
	N	P	K	S	N	P	K	S
Mixed fertilizer (7.58-14.44-11.53-4.44)	78	19	117	12	92	16	116	10
Complex fertilizer (16-16-16)	85	18	109	11	90	18	107	11
Complex fertilizer (23-23)	79	18	120	10	89	20	110	13
Straight fertilizer (Urea, TSP, MP and gypsum)	79	19	118	10	101	17	111	10
No fertilizer (control)	29	5	40	3	33	6	45	3
LSD (0.05)	8.5	2.2	26.3	1.2	10.1	2.2	7.9	1.2

difference in grain and straw yield. Total uptake of N, P, K and S by BR3 ranged from 29–85, 5–19, 40–120 and 3–12 kg/ha, respectively. On the other hand total uptake of N,P,K and S by BR11 ranged from 33–101, 6–20, 45–116 and 3–13 kg/ha, respectively. In most of the cases, nutrient uptake pattern was statistically similar among the fertilizer sources in both the seasons. This was expected as the difference was not significant at all among the fertilizer sources. Total uptake of N, P, K and S by rice plant, recorded in the present study, are in agreement with some previous findings [10, 13, 14].

The findings of this study indicated that mixed and complex fertilizers are as good as straight fertilizers in increasing the grain yield of wetland rice. These fertilizers may be suitable alternatives to straight fertilizers for balanced fertilization.

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