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Residual Effect of Nutrients Content in Rice as Influenced by Zinc Fertilization

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Abstract: A field experiment was conducted to evaluate the different brands of zinc fertilizer produced and marketed in different areas of Bangladesh and their effect on nutrients content in rice (BRRI dhan 32). Among the nutrients; the content of N, S and Ca in grains and straw did not vary significantly, but the contents of P, K, Na, Mg, Zn, Cu, Fe and Mn in grain and straw varied significantly due to the application of different brands of zinc fertilizer. The nutrient content in grain was the highest N, P, K, Na, Ca, Mg, S are 1.279, 0.0415, 0.2017, 0.0785, 0.1607, 0.3187, 0.187% and Zn, Cu, Fe, Mn are 10.77, 8.963, 185.30, 61.33 ppm, respectively. On the other hand, the highest content of N, K, Na, Ca, S are 0.709, 5.040, 0.0760, 0.3739, 0.208 % was found in straw,respectively and Zn, Cu, Fe, Mn are 56.65, 55.79, 263.7, 548.8 ppm, respectively. It is apparent that Zn-2 induced highest accumulation of P, Zn, Cu and Mn in rice grain, whereas in straw this brand induced the highest concentration of N, Fe and Mn. The concentration of Zn in both rice grain and straw appeared less in amount in most of the treatments as compared to control except that grain due to Zn-2.

Key words: Zinc fertilizer, Rice, Performance, Nutrients content.

INTRODUCTION

The fertility status of the soil in Bangladesh it has gone down due to intensive crop cultivation and this is more prominent particularly in rice crop. Since rice is grown in wet condition; diverse soil and climatic situations may cause deficiency of micro and along with some other factors or macronutrients. Deficiency of zinc and response of rice to zinc under flooded condition have been studied [1]. The available zinc content of several soil samples collected from different districts of Bangladesh varied from extremely deficient to fairly adequate level. It has resulted from continuous exhaustion of soil nutrients without replenishment of fertility by application of adequate amount of proper fertilizers, soil management practices and regular crop rotation. To over come this adverse situation application of zinc fertilizer has been recommended for rice in Bangladesh [1-2]. Application of zinc in the form of zinc sulphate ($ZnSO_4$) has been reported to be effective to increase grain yield to a considerable extent. Since the establishment of the deficiency of zinc in Bangladesh several entrepreneurs have started producing the zinc fertilizer under different trademarks/brands and marketing those throughout the country in different packets and labels. The performance of those products drew the attention of both public and research works; present study was therefore, undertaken to study some of those zinc fertilizer products produced and marketed in different areas of the country and their response to rice in respect of nutrient content there in.

MATERIALS AND METHODS

A high yielding variety of rice (BRRI Dhan 32) was used as the test crop in the experiment and was laid out in a randomized complete block design (RCBD) with three replications. Locally produced and marketed different brands of zinc fertilizers have been used which include eight treatments viz: Zn-1, Zn-2, Zn-3, Zn-4, Zn-5, Zn-6, Zn-7 and Zn-8 including one control receiving no Zn fertilizer. The different brands of Zn fertilizer used in the experiment were Zn-1: krishak marka sada dasta sar, Zn-2: langal marka sada dasta sar, Zn-3: Jamuna dasta sar, Zn-4: Moi marka sada dasta sar, Zn-5: Mukta zinc sulphate,

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Zn-6: Krishan marka shada dasta sar, Zn-7: Krishak bandu marka dasta sar, Zn-8: Jora singha dasta sar which Zn content was 18.4, 19.8, 20.0, 19.8, 9.3, 18.9, 11.0 and 26.0 %,respectively.

The plant materials at soil level were collected at harvest stage from 10 selected hills per plot and grain were threshed immediately. Both grain and straw samples were cleaned, oven dried at 65°C over night then dried materials were ground in a grinding machine and preserved in polythene bags for chemical analysis. Exactly 1 g of finely ground grain and straw materials were taken separately into a 250 mL conical flask and 10 mL of di-acid mixture (HNO_3: $HC1O_4$ = 2:1) was added to it. The conical flask with sample was placed on an electric hot plate for heating at 180-200°C until the solid particles disappeared and white fumes were evolved from the flask. Then it was cooled at room temperature, washed with distilled water and filtered into 100 mL volumetric flasks through Whatman No. 42 filter paper making the volume up to the mark with distilled water following wet oxidation method; the content total nitrogen in rice grain and straw samples was determined by macro Kjeldahl method; available Phosphorous is determined calorimetrically by stannous chloride method [3]. Potassium and sodium content was determined separately with the help of a flame emission spectrophotometer using appropriate potassium filter and sodium filter [4-5]; calcium and magnesium content in rice grain and straw was estimated by complexometric method of titration using Na_2EDTA complexing agent following the method as describe [6] and sulphur content was determined turbidimetrically following the method [7]; while the concentrations of Zn, Cu, Fe and Mn in grain and straw samples were determined by atomic absorption spectrophotometer according to the method outlined [8]. All the data were analyzed statistically and the results were adjudged by the Duncan's Multiple Range Test with the help of a computer package M-STAT program.

RESULT AND DISCUSSION

Results revealed the except N, S and Ca the content of all other nutrient element studied (P, K, Na, Mg, Zn, Cu, Fe and Mn) in rice grain (BRRI dhan 32) varied significantly at 1-5% level of probability (Table 3) while in straw content of N, S, Ca and Mg only did not vary significantly (Table 4) due to the application of different brands of Zn fertilizer produced and marketed in different region of Bangladesh. It was further observed that the content of all the nutrients elements in rice grain and straw of cv. BRRI dhan 32 was quite different due to the application of different brands of Zn fertilizer.

Experimental Soil and Fertilizer Status: Non calcareous flood plain soil was collected and their analyzing results of physical and chemicals properties are presented in Table 1; the fertilizer status of nutrient contented are also presented in Table 2. The standard level of Zn content is 18-23% where the present status is found with in range limit except Zn-5 and Zn-7 where the Zn content is lower limit.

Nitrogen Content: The content of nitrogen in grain varied from 1.041 to 1.279 %. The maximum N content (1.279 %) in grain was obtained in the treatment Zn-6. The concentration of nitrogen in straw varied from 0.565 to 0.709 % (Table 4) and the highest N content in straw (0.709 %) was observed in the treatment Zn-2. Its concentration in grain was higher than in straw in all the treatments.

Phosphorus Content: The content of P varied from 0.00766 to 0.0415 %. The maximum P content was recorded (Zn-2) due to the application of the results revealed the most of the brands had significant effect on P. Less effect on P concentration in rice grains, through the variation was significantly influenced by the different brands. The accumulation of P in rice straw was less affected by the different brands, the concentration of P was highest in Zn-1 followed by Zn-8 and Zn-7 and it was minimum in Zn-5. Some of the brands induced less accumulation of P in rice straw as compared to control. From these results Talukder [9] reported an antagonistic effect of Zn and P fertilizer. Singh *et al*. [10] reported that Zn application increased the P concentration in rice grain and straw. Akhter *et al.* (11) studying the interaction of P and Zn observed that P concentration suppressed the Zn adsorption by rice plant and vice versa in calcareous soil.

Potassium Content: The content of K content in rice grain ranged form 0.1727 to 0.2017 %. The maximum K content (0.2017 %) in grains was obtained by the treatment Zn-8 followed by Zn-2 (0.2013 %). Zaman *et al.* [12] in a trial on non calcareous dark grey flood plain soil reported that Zn application decreased K content in rice grain but when applied in calcareous with P it influenced the accumulation of Zn along with P, S and Mn. In this study since we used P with other fertilizer components as basal dose, it is assumed that the same phenomenon might have taken place here also. Results in Table-2 also show that the K concentration in rice straw was significantly influenced by the treatments. The highest K content (5.040 %) was recorded due to Zn-1 and it was the lowest (3.100 %) in the treatment Zn-4. From the Table 2 it

Table 1: The physical and chemical properties of pre planting soil of the experimental field

			Sand (%)		Silt (%)	Clay (%)
	Particle size analysis:		8.84		72.00	19.61
Physical properties	Textural class		Silt loam			
Chemical properties						
pH	Organic carbon (%)	Organic Matter (%)	Total N (%)	Available P (ppm)	AvailableS (ppm)	ExchangeableK(me/100gsoil)
6.80	0.662	1.14	0.12	13.0	14.20	0.23
Mg (me/100g soil)	Zn (ppm)	Cu (ppm)	Fe (ppm)	Mn (ppm)	B (ppm)	Ca(me/100g soil)
14.68	2.58	15.45	258.7	39.45	0.987	5.13

Table 2: Nutrients content of 8 different produced and marketed Zn fertilizer analyses results

Fertilizer	Zn %	Cu (ppm)	Fe %	Mn (ppm)
Zn-1	18.4	Tr	0.09	57.60
Zn-2	19.8	Tr	0.34	15.70
Zn-3	20.0	Tr	0.05	12.10
Zn-4	19.8	93.00	0.75	23.00
Zn-5	9.3	2.80	1.21	157.6
Zn-6	18.9	Tr	0.79	119.5
Zn-7	11.0	17.5	0.06	297.90
Zn-8	26.0	84.10	0.45	248.3

Note: Tr = Trace

Zn-1: krishak marka sada dasta sar, Zn-2: langal marka sada dasta sar, Zn-3: Jamuna dasta sar, Zn-4: Moi marka sada dasta sar, Zn-5: Mukta zinc sulphate, Zn-6: Krishan marka shada dasta sar, Zn-7: Krishak bandu marka data sar, Zn-8: Jora singha dasta sar.

Table 3: Effect of different brands of Zinc fertilizer produced and marketed in Bangladesh on the content of different nutrient elements in rice grain (BRRI dhan 32)

Treatments	N(%)	P(%)	K(%)	S(%)	Na(%)	Ca(%)	Mg(%)	Znppm	Cuppm	Feppm	Mnppm
Control	1.120	0.0129 de	0.1733 d	0.187	0.07067 b	0.1067	0.2613 abc	7.750 b	5.333 bc	142.00 c	45.23 bc
Zn-1	1.148	0.0300 b	0.1843 b	0.128	0.01300 f	0.1034	0.3187 a	7.300 b	4.167 d	67.67 f	26.09 g
Zn-2	1.155	0.0415 a	0.2013 a	0.125	0.01667 f	0.0872	0.2547 abc	10.77 a	8.963 a	112.30 d	61.33 a
Zn-3	1.097	0.00766 e	0.1747 d	0.156	0.0625 c	0.09387	0.2067 bc	7.350 b	5.427 b	80.33 e	48.53 b
Zn-4	1.041	0.01550 d	0.1810 bc	0.157	0.0425 e	0.100	0.2447 abc	7.050 b	3.133 e	149.00 b	42.63 cd
Zn-5	1.204	0.01753 cd	0.1727 d	0.135	0.04967 d	0.0617	0.2540 abc	4.067 c	4.460 cd	66.00 f	40.16 d
Zn-6	1.279	0.01167 de	0.1760 cd	0.124	0.04373 e	0.0750	0.1890 c	5.900 bc	4.193 d	185.30 a	34.82 e
Zn-7	1.097	0.01267 de	0.1727 d	0.130	0.06253 c	0.0450	0.2907 ab	5.960 bc	5.453 b	81.29 e	30.65 f
Zn-8	1.069	0.02267 c	0.2017 a	0.129	0.07853 a	0.0814	0.2757 ab	7.900 b	5.743 b	145.0 bc	46.67 b
CV%	13.54	11.61	4.89	22.08	27.49	27.74	13.57	19.18	7.10	0.236	3.47
S_x	0.0887	0.00183	0.00183	0.0180	0.001867	0.01826	0.0182	0.7878	0.2137	1.5550	0.8375

Note: In a column figures showing similar letter (s) did not differ significantly according to DMRT. All the data are mean value of three replications with the 27 number of independent samples.

Zn-1: krishak marka sada dasta sar, Zn-2: langal marka sada dasta sar, Zn-3: Jamuna dasta sar, Zn-4: Moi marka sada dasta sar, Zn-5: Mukta zinc sulphate, Zn-6: Krishan marka shada dasta sar, Zn-7: Krishak bandu marka data sar, Zn-8: Jora singha dasta sar.

Table 4: Effect of different brands of Zinc fertilizer produced and marketed in Bangladesh on different nutrients rice straw (BRRI dhan 32)

Treatments	N(%)	P(%)	K(%)	S(%)	Na(%)	Ca(%)	Mg(%)	Zn ppm	Cu ppm	Feppm	Mnppm
Control	0.658	0.0455 b	4.217 b	0.080	0.076 a	0.2815	0.482	56.65 a	31.67 c	119.3 bc	404.300 d
Zn-1	0.565	0.0683 a	5.040 a	0.048	0.056 b	0.3739	0.547	44.37 bcd	47.53 b	94.64 c	384.4 00 d
Zn-2	0.709	0.0493 b	3.967 c	0.088	0.041 c	0.3072	0.574	54.85 ab	22.25 d	236.70 a	548.800 a
Zn-3	0.681	0.0240 c	4.367 b	0.208	0.032 d	0.3205	0.547	40.33 cd	22.77 d	111.00 bc	465.300 bc
Zn-4	0.642	0.0183 d	3.100 d	0.055	0.045 c	0.2937	0.563	38.14 d	23.87 d	140.00 bc	407.300 d
Zn-5	0.588	0.0117 d	3.900 c	0.120	0.041 c	0.3205	0.545	44.90 bcd	21.38 d	106.30 bc	487.900 b
Zn-6	0.583	0.0150 d	4.210 b	0.113	0.061 b	0.2001	0.529	54.55 ab	32.73 c	173.30 b	439.700 bcd
Zn-7	0.663	0.0657 a	3.997 c	0.086	0.041 c	0.2136	0.578	42.58 cd	55.79 a	148.70 bc	283.100 e
Zn-8	0.663	0.0673 a	4.303 b	0.146	0.061 b	0.3205	0.464	51.73 abc	22.38 d	123.30 bc	421.000 cd
CV%	27.25	30.65	2.41	55.21	2.45	23.28	17.92	12.94	4.66	19.02	4.97
S_x	0.1005	0.0018	0.0577	0.0334	0.0018	0.0408	0.0555	3.555	0.8373	15.29	12.25

Note: In a column figures showing similar letter (s) did not differ significantly according to DMRT. All the data are mean value of three replications with the 27 number of independent samples.

Zn-1: krishak marka sada dasta sar, Zn-2: langal marka sada dasta sar, Zn-3: Jamuna dasta sar, Zn-4: Moi marka sada dasta sar, Zn-5: Mukta zinc sulphate, Zn-6: Krishan marka shada dasta sar, Zn-7: Krishak bandu marka data sar, Zn-8: Jora singha dasta sar appears that except Zn-1 and Zn-3 all other brands either reduced or maintained the same K status in rice straw. It can further be noticed (Table 3 and 4) that percent K content in straw is quite higher than that of rice grains. It seems imperative that whatever be the source Zn affects the K content in rice grain and straw.

Sodium Content: The maximum Na concentration (0.0785 %) in rice grain was recorded in Zn-8 which was significantly different from that of other treatments (Table 3). The highest concentration of Na (0.0760 %) was found in control which was statistically different from the rest of the treatments. From the results (Table 3 and 4) it is evident that the different brands of Zn fertilizer available in the local markets behaved differently on the sodium content in rice grains and straw. In almost all the cases Zn application reduces the concentration of Na in both grain and straw. Tisdale *et al.*[13] stated that sodium concentrations as little as 1 to 2 % in sensitive crops lowers the yield. They also reported that high sodium levels in plants are often accompanied by low potassium. This phenomenon is in confirmatory with this study.

Calcium Content: The highest Ca concentration in grains (0.1607 %) was obtained in control treatment and in straw that was with Zn-1 treatment (0.3739 %). The lowest Ca concentration in grain and straw was 0.045 and 0.200 % in Zn 7 and Zn-6,respectively. Tisdale *et al.* [13] stated that Calcium is abundant in leaves and has a role in all elongation. There is often a poor supply in fruits and storage organs. From this statements it is evident that Ca content in rice grain and straw may indeed by negligible which has been observed in this study.

Magnesium Content: The highest Mg concentration (0.3187 %) was found in Zn-1 treatment which are statistically identical to all other treatments except Zn-3 and Zn-6 while Mg concentration in straw did not differ significantly due to the treatments (Table-4) having the highest concentration in the straw with the treatment of Zn-7 and lowest in Zn-8 which was inferior to the control. Since magnesium is a mobile element and is readily translocated from older to younger parts of the plant and is involved in various physiological and biochemical functions, is a constituent of chlorophyll [13] its accumulation in small amounts in grains and straw of rice which we obtained in the present study is therefore obvious. It seems further that the application of Zn fertilizer had little influence on Mg content in rice grains and straw.

Sulphur Content: The S content in rice grain ranged from 0.124 to 0.187 % (Table 3). The maximum content (0.208 %) being in control treatment. The lowest concentration was due to Zn-6. Zaman *et al.* [12] reported that S content in rice grain was decreased by Zn application though not significant this statement is in agreement with our results. The S content in straw ranged from 0.048 to 0.208 % (Table 4). The maximum S content in straw was recorded in treatment Zn-3 and the it was lowest in Zn-1. The accumulation of S was higher amount in rice straw than that in grain.

Zinc Content: The maximum Zn concentration in grain (10.77 ppm) was found in Zn-2 which was statistically different from all other treatments. The different brands of Zn treatments except (Zn-2) had little or negative response as regards to Zn content in grain compared to the control. Sakal *et al.*, [14] reported that application of Zn fertilizer increased the Zn content in rice grain. The concentration of Zn in straw was the maximum (56.65ppm) in control which is statistically similar to Zn-2 (54.85 %), Zn-8 (51.73 %) and Zn-6 (54.55 %). Zn content in straw was found much superior to that in grains of rice. Singh [15] showed that Zn application significantly increased Zn concentration in various plant parts.

Copper Content: The maximum Cu concentration in rice grain (8.963ppm) was found in Zn-2 followed by Zn-8 (7.743 ppm). The content of Cu due to Zn-7 (5.453 ppm), Zn-3 (5.427 ppm) and control (5.33 ppm) was almost identical. The Cu concentration in straw was also significantly different among the treatments. The maximum Cu concentration (55.79 ppm) was found in Zn-7 and it was lowest in Zn-5 (21.38 ppm). The results indicate that the concentration of Cu in straw was higher as compared to that of grains of BRRI Dhan 32.

Iron Content: In rice grain the maximum Fe concentration (185.30 ppm) was found in Zn-6 followed by Zn-4 (149 ppm), Zn-8 (145 ppm) and control (142 ppm). The lowest (66.0 ppm) Fe was obtained in Zn-5 which is similar to Zn-1 while the maximum Fe concentration (236.7 ppm) in straw was found in Zn-2 and it was lowest in Zn-1 (94.64 ppm). It appears (Table 3 and 4) that concentration of Zn in rice grain and straw was different in different treatment. But it is difficult to predict if it was due to particular brand of Zn fertilizer, because the variation in Fe concentration in grain due to the application of different brands of Zn fertilizer did not maintain the same sequence.

Manganese Content: The maximum Mn concentration in rice grains (61.33 ppm) was found in Zn-2 followed by Zn-3, Zn-8 and control and it was minimum (26.09 ppm) in Zn-1. The Mn concentration in straw ranged from 283.1 to 548.8 ppm (Table-4). The maximum Mn concentration was found in Zn-2 treatment. Among the eight different brands of Zn fertilizer, 50 % are statistically identical with the control. So the different Zn treatments had no effective response, in respect of Mn conc. in rice straw [16]. It can be seen (Table 3 and 4) that different brands of Zn fertilizer had acted differently on the content of Mn in rice grains and straw although the amount of Mn in rice grain was much higher than that in rice straw.

CONCLUSION

The content of nutrients (N, P, K, S, Na, Ca, Mg, Zn, Cu, Fe and Mn) in rice grain and straw as influenced by different brands of Zn fertilizer produced and marketed in Bangladesh was studied significantly. It is apparent that Zn-2 induced highest accumulation of P, Zn, Cu and Mn in rice grain whereas in straw this brand induced highest concentration of N, Fe and Mn. The concentration of Zn in both rice grain and straw appeared less in amount in most of the treatments as compared to control except that grain due to Zn-2. This poses a big question about the purity of the brands of Zn fertilizer produced and marketed locally in Bangladesh.

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