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DIRECT AND RESIDUAL EFFECT OF SULPHUR AND ZINC ON POTATO-BORO-T. AMAN RICE CROPPING PATTERN

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ABSTRACT

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) sub-staion, Tajhat, Ranpure, using potato-Boro-T. aman rice cropping pattern with an objective to evaluate the direct and residual effects of sulphur and zinc on the growth, yield and nutrient uptake by the crops. The surface soil was sandy loam texture, pH 6.3, organic matter 1.24%, available sulphur 6.62 ppm and available zinc 0.45 ppm. The experiment comprised of eight treatments for potato $S_{15}Zn_2$ (T_2, T_4 and T_8), S_8Zn_1 (T_5 and T_6) and S_0Zn_0 (T_1, T_3 and T_7), for boro rice $S_{20}Zn_4$ (T_3, T_5, T_6 and T_7) and S_0Zn_0 (T_1, T_3, T_4 and T_6). The experiment was laid out in a randomized complete block design with three replications. Average tuber yield of potato (var. cardinal) varied from 28.29 to 32.86 t ha^{-1} with the highest yield in $S_{15}Zn_2$ treatment (100% recommended dose) and the lowest was in the S_0Zn_0 treatment (control). In the second crop (Boro rice), growth and yield attributes, grain and straw yields responded significantly to S and Zn applied either in the first crop or in both crops. The average grain yield varied from 3.51 to 5.27 t ha^{-1} over the treatments. In the third crop (T.aman rice), the grain and straw yields responded significantly to S and Zn applied either in the first and second crop or in the third crops. The grain yield of T.aman rice varied from 2.96 to 4.46 t ha^{-1} over the treatments. The growth and yield contributing characters were also significantly influenced by the treatment. There was a significant direct and residual effect of the treatments on S and Zn uptake by the crops.

Key words : Residual effect, Sulphur, Zinc

INTRODUCTION

Potato is used as a staple food in many countries of the world, but absolutely as a vegetable in Bangladesh and rice is staple food. The yield of potato (14.87 t ha^{-1}) and rice (2.43 t ha^{-1}) is still lower than their potential yield (BBS, 2005). Potato-Boro-T.aman rice cropping pattern is a dominant cropping pattern of AEZ 3 but its total nutrient removal is high. The rice and coarse cereal based cropping systems in arid, semi-arid, humid and coastal ecosystems have proved that the deficiencies of S and Zn in the soils are responsible for slow growth in food grains production in the country (Shukla *et.al.,* 2002). The yield of these crops can further be increased with proper management practices like use of modern high yielding varieties, irrigation, plant protection, judicial application of fertilizer etc. Use of balanced fertilizers requires secondary and micronutrients along with NPK. The application of micronutrients in addition to essential major elements can play a

good role in increasing the yield of potato tubers (Islam *et al.*, 1986, Mondal *et al.*, 1993). Nutrient elements especially zinc, boron sulphur and magnesium not only increase the yield of potato but also improve the quality of Potato tubers (Taya *et al.*, 1994). Sulphur and nitrogen are both constituents of plant protein. Sulphur and zinc fertilizers have residual effect on the following crops (Main and Eaqub, 1984; Islam *et al.*, 1997). Continuous application of large amount of secondary and micronutrients can be toxic to plants. Therefore, it is important to study the direct and residual effects of these nutrients on the performance of crops grown in Potato-Boro-T.aman rice cropping pattern.

MATERIALS AND METHODS

The experiment was conducted at BINA sub-station, Rangpur under Tista Meander Floodplain (AEA 3) during 2000-2001 to 2002-2003 with Potato-Boro-T. aman rice cropping pattern. The cultivars used in this experiment were Cardinal for Potato, Iratiom-24 for Boro rice and BINA dhan-4 for T.aman rice. There were eight treatments in different combinations with S and Zn replicated thrice in randomized complete block design. Detail of treatment combinations in Table 1. A blanked dose of $N_{120}P_{25}K_{70}$ for potato, $N_{120}P_{25}K_{60}$ for Boro rice $N_{80}P_{15}K_{40}$ kg ha^{-1} for T. aman rice was applied as basal. Nitrogen was applied in three equal splits. The source of N, P, K, S and Zn was urea, TSP, MP, gypsum and zinc sulphate respectively. One-third of urea was applied as basal to the individual plots during final land preparation. The second split of urea was applied at maximum tillering stage and the remaining split at panicle initiation stage. Intercultural operation was done as and when required. Supplementary irrigation was done as per requirement. Initial soil samples were collected and analyzed at Soil Science laboratory BINA, following standard procedure. Soil characteristics of the collected samples are given in the Table 2. The nutrient uptake was calculated by the formula:-

Table 1. Treatment combinations of different doses of and Zn for Potato-Boro-T. aman rice

Treatment	Potato	Boro rice	T. aman rice
T_1	0	0	0
T_2	Direct + Residual	Residual	Direct + Residual
T_3	Residual	Direct	Residual
T_4	Direct	Residual	Residual
T_5	Direct + Residual	Direct + Residual	Direct + Residual
T_6	Direct + Residual	Direct + Residual	Residual
T_7	Residual	Direct + Residual	Direct + Residual
T_8	Direct + Residual	Residual	Direct + Residual
Blank dose NPK(kg/ha)	$N_{120}P_{25}K_{70}$	$N_{120}P_{25}K_{60}$	$N_{80}P_{15}K_{40}$

For potato: 15 kg S ha^{-1} and 2 kg and 2kg Zn ha^{-1} were considered as 100% as 100% and 8 kg S ha^{-1} 1kg kg Zn ha^{-1} were considered as 50% of recommended dose.
For Boro rice: 20 kg S ha^{-1} and 4 kg Zn ha^{-1} were considered as 100% of recommended dose
For T. aman rice: 10 kg S ha^{-1} and 2 kg Zn ha^{-1} were considered as 100% recommended dose

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient concentration (\%) x Yield (kg/ha)}}{100}$$

Table 2. Soil characteristics of the experimental site at BINA substation

	pH	OM (%)	Total N (%)	Available nutrients (ppm)				Exchangeable cations (meq%)		
				P	S	Zn	B	K	Ca	Mg
Characters	6.3	1.24	0.06	12	6.62	0.45	0.69	0.19	2.40	0.85
Interpretation	Slightly acidic	Very low	Very low	Low	Very Low	Very Low	High	Medium	Low	Medium

RESULTS AND DISCUSSION

Potato

Tuber yield of potato was significantly increased due to direct and residual effect of added S and Zn fertilizers (Fig 1). Direct application (T_4) of S and Zn in potato significantly increased tuber yield over that of their residual effects from application of these nutrients either in boro rice (100%, T_3) or in both boro and T.aman rice (50%, T_7). Effects of direct application of S and Zn (100%) and direct plus residual effect on tuber yields were found similar. But when the rates of direct application was 50% (T_5 or T_6) tuber yield were significantly reduced.

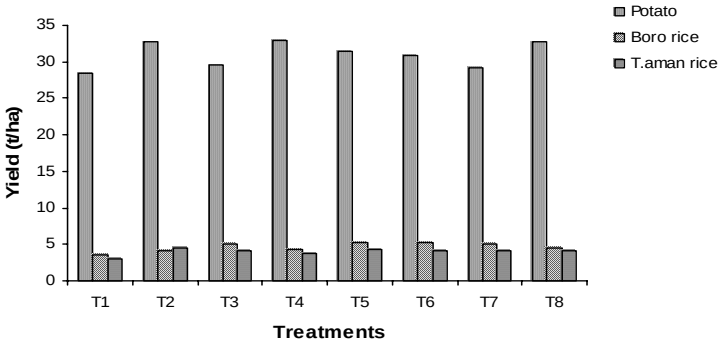

Fig. 1. Direct and residual effect of S and Zn on Tuber/Grain Yield

The above results confirm that low content of soil S and Zn needed direct application of S and Zn at 100% for high yield of potato. Similar result was also confirmed by Bari *et al.* (2001).

Boro rice

The grain yield of boro rice was significantly increased due to direct and residual effect of added S and Zn fertilizers (Fig 1). Direct application of S and Zn in boro rice (100%, T_3) significantly increased grain yield over that of their residual effects form application of these nutrients (100%) either both in potato and T. aman rice (T_2) or in potato (T_4). The

yields of direct application of S and Zn (T_3) and their direct application plus their residual effects (50% applied in potato and T. aman rice in T_5, T_6 and T_7 were similar. This is an agreement with the findings of Naik *et al.* (2006).

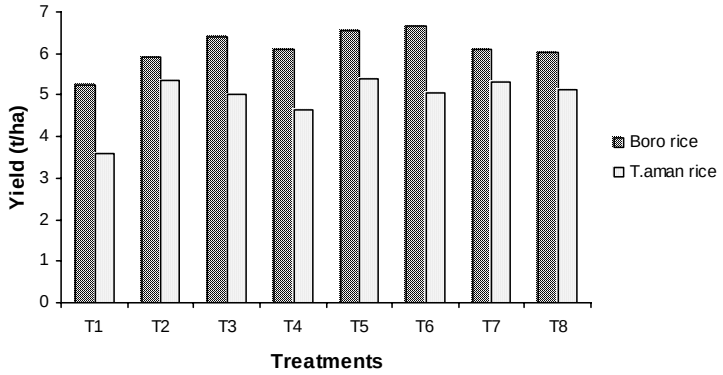

Fig. 2. Direct and residual effect of S and Zn on straw yields of rice

T. aman rice

The grain and straw yields of T. aman rice (var. BINA dhan-4) significantly increased due to direct plus residual effect of S and Zn application (Fig 1 & Fig 2). Direct application of S and Zn (100%, T_2) in T. aman rice plus residual effect of these nutrient applied in potato significantly increased grain yield compared to that of their direct application (50%, T_8) plus residual effects of nutrient applied in potato. Application of S and Zn only in potato gave significantly second lowest yield of rice (Boro and T. aman rice). In general, grain and straw yields were higher with direct plus residual effects of S and Zn compared to their only residual effects. This finding is well collaborated with the findings of Jahiruddin *et al.* (2007).

Nutrient uptake

The amounts of N, P, K and S uptake by Potato-Boro-T. aman rice as affected by different treatment combinations are presented in Table 3. Nutrient uptake increase with increased of yield. The highest uptake was found in T_5 treatment in case of P and K but N and S it was both treatment T_2 and T_8. Uptake ranged among the nutrients 311-444, 160-202- 682-920 and 42-67 kg ha^{-1} for N, P, K and S respectively.

Nutrient balance

Balance for N and K was highly negative while as P and S shows less negative balance. This may be happened due to higher biomass yield and higher uptake. The apparent nutrient balance in the treatments of the experiment for N range from -183 to 316 kg ha^{-1}, P -95 to -137 kg ha^{-1}, K -512 to -750 kg ha^{-1} and S -18 to -42 kg ha^{-1}, respectively (Table 3).

Cost and return of fertilizer

The highest gross margin of Tk. 2,28,865 ha^{-1} was obtained with the treatment T_5 which received direct application of 50% of S and Zn in potato and T. aman rice and 100% in boro rice. The second highest gross margin of Tk. 2,26,651 ha^{-1} in T_2 which received direct application of 100% S and Zn. The highest MBCR (1.51) was obtained in T_5 though highest variable cost was also with the same treatment (Table 4).

Table 3. Nutrient uptake and balance (kg/ha) as affected by different combinations of S and Zn

Treatment	Nutrient added					Nutrient uptake					Nutrient balance				
	N	P	K	S	Zn	N	P	K	S	Zn	N	P	K	S	Zn
T_1	320	65	170	-	-	311	160	682	42	0.80	-183	-95	-512	-42	-0.80
T_2	320	65	170	25	4	444	190	844	58	1.3	-316	-125	-674	-33	2.69
T_3	320	65	170	10	4	403	191	821	49	1.17	-275	-126	-651	-29	2.82
T_4	320	65	170	15	2	425	188	889	54	1.12	-297	-123	-719	-39	0.79
T_5	320	65	170	33	6	416	202	920	51	1.26	-288	-137	-750	-18	4.74
T_6	320	65	170	28	5	410	195	864	48	2.44	-282	-130	-694	-20	2.56
T_7	320	65	170	25	5	403	183	818	55	1.17	-275	-118	-648	-30	3.83
T_8	320	65	170	20	3	399	195	863	67	1.24	-271	-130	-693	-47	1.76

Table 4. Cost and return analysis of different treatments of Potato-Boro rice-T. aman rice

Treatment	Gross return (TK./ha)	TVC (TK./ha)	Gross margin (TK./ha)	Marginal gross margin (TK./ha)	MBCR
T_1	2,02,600	_	2,02,600	_	_
T_2	2,43,4900	16,893	2,26,651	24,051	1.42
T_3	2,32,470	16,529	2,15,941	13,341	0.81
T_4	2,40,060	16,309	2,23,751	21,151	1.30
T_5	2,46,300	17,435	2,28,865	26,265	1.51
T_6	2,40,050	17,095	2,22,955	20,355	1.19
T_7	2,31,240	17,073	2,14,167	11,567	0.68
T_8	2,41,870	16,649	2,25,221	22,621	1.36

TVC = Total Variable Cost, MBCR = Marginal Benefit Cost Ratio.
Price of N as urea = Tk. 14.0/kg, P as TSP = Tk. 77.0/kg as MP Tk. 18.0/kg, S as Gypsum = Tk. 22/0/kg 4 additional from –days are required for applying fertilizer per hectare and 4 additional man-days are required for 1 ton of additional product including by product. Labor wage/day = Tk. 70.0, price of Potato = Tk. 10,00/t, Rice grain = Tk. 8,000/t and Straw = Tk. 1,000/t.

CONCLUSION

Direct application of 100% S (15 kg/ha) and Zn (2 kg/ha) in all component crops significantly increased the yields of the crops. But considering the cost and return,

application of 50% of S (8 kg/ha) and Zn (1 kg/ha) in potato and T. aman rice and 100% in boro rice found most profitable.

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