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Effects of Sulphur, Zinc and Boron On Yield, Yield Components and Nutrient Uptake of Wheat

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A field experiment was carried out in an alluvial soil of Bangladesh to study the effect of S, Zn and B on yield, yield components and nutrient uptake by wheat (cv. Kanchan). There were eight treatments consisting of control, S, Zn, B, S+Zn, S+B, Zn+B and S+Zn+B. The rates of application of S, Zn and B were 20, 4 and 3 kg ha^{-1} in the form of gypsum, zinc oxide and boric acid, respectively. Basal doses of 100 kg N ha^{-1} as urea, 60 kg P_2O_5 ha^{-1} as TSP and 40 kg K_2O ha^{-1} from muriate of potash were applied to all plots. The experiment was carried out in randomized block design with four replications. The application of S, Zn and B significantly increased plant height, effective tillers $palnt^{-1}$, spike length, grain $spike^{-1}$, 1000-grain weight and grain and straw yields of wheat. The effect of S was dominant in increasing grain yield followed by B and Zn applications. The highest grain yield of 25.82 q ha^{-1} was obtained when S, Zn and B were applied together which was 42% higher over control. Nutrient analysis of grain and straw indicated that S, Zn and B contents were significantly influenced by the treatments. The content of S, Zn and B in grain was higher when a particular nutrient was applied. Thus, for efficient wheat production in this soil, application of S, Zn and B is essential.

Key words: Micro nutrient uptake, Wheat, Yield.

Introduction

The adaptation of intensive cropping with new varieties is one of the major efforts to increase crop production in Bangladesh. This, in turn resulted in a marked depletion of inherent nutrient reserves in soils (Ali 1992; Karim *et al* 1994). In tropical and subtropical climate, low organic matter reserve and rapid weathering of minerals accompanied by leaching of soluble nutrients with monsoon rains and irrigation water are likely to favour the deficiency of micronutrients. In Bangladesh, N, P and K were the deficient nutrient elements for crop production in the near past but nowadays the deficiency of S, Zn and B is frequently reported in some soils and crops (Islam and Hossain 1993; Islam *et al* 1996). Wheat is the second most important food crop after rice in Bangladesh and is gaining popularity among the people. Hence, the present study was conducted to determine the effect of application of S, Zn and B on the growth, yield and nutrient uptake by wheat.

Materials and Methods

The experiment was carried out in a farmer's field in an alluvial soil of Bangladesh during cropping season of 1992-93. The soil was sandy loam in texture having pH 5.8; total-N 0.08%; Olsen's P 17.0 mg kg^{-1}; NH_4OAC extractable K 0.15 meq 100 g^{-1}; $CaCl_2$ extractable S 8.2 mg kg^{-1}; 0.1M HCl extractable Zn 2.1 mg kg^{-1} and monocalcium phosphate extractable B 0.28 mg kg^{-1}. The experiment was laid out in randomized block design with four replications. Eight treatments containing three nutrients (S, Zn and B) in all combinations were given. The dose for S, Zn and B were 20, 4 and 2 kg ha^{-1}, respectively. The nutrients were incorporated in soil in the form of gypsum, zinc oxide and boric acid, respectively. Every plot received an equal amount of N, P and K which were added at the rate of 100 kg N ha^{-1} as urea, 60 kg P_2O_5 ha^{-1} as TSP and 40 kg K_2O ha^{-1} as muriate of potash. All the fertilizers except urea were added to soil during land preparation before sowing. Urea was added in three equal splits, the first dose at sowing and the remaining doses at 28 and 56 days after sowing. Intercultural operations such as irrigation, weeding and pesticide application were done as and when required. The wheat variety used was Kanchan. The wheat seeds were sown on December 3, 1992 at a rate of 120 kg ha^{-1} continuously in lines 20 cm apart. The crop was harvested at full maturity on March 27, 1993. Observations were made on yield and yield components. Along with yield components, data on chemical analysis of grain and straw were recorded by acid digestion method (Page *et al* 1989). Nutrient uptake by grain or straw was calculated from the yield and nutrient content data.

Results and Discussion

Grain yield responded significantly to the applied nutrients (Table 1). The treatment of S+Zn+B produced the highest grain yield of 25.82 q ha^{-1} which was statistically identical with that

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recorded in S+B treatment. The grain yield recorded in S+B treatment was at par with those obtained in S, B, S+Zn and Zn+B treatments. Application of element S alone resulted in 25% yield increase over the control as against the yield increment of 21% by single application of B and 12% by single application of Zn. When S, Zn and B were applied together, the grain yield increased by 42%. Similar response of wheat due to application of S, Zn and B was also reported by different researchers (Jahiruddin *et al* 1992; Abedin *et al* 1994).The application of nutrients (S, Zn and B) revealed a significant effect on straw yield of wheat. The application of S alone produced significantly higher straw yield as compared to the control treatment but single application of Zn or B could not produce significantly higher straw yield as compared to the control. The highest straw yield was statistically identical to that recorded when S and Zn were applied together. Such type of response of wheat to S and B is expected as the available S and B status of the soil was below the critical level and the available Zn was slightly above the critical level (Karim *et al* 1989).

The applied nutrients significantly increased plant height, effective tillers plant^{-1}, spike length, grains spike^{-1} and 1000-grain weight of wheat (Table 1). The effect of S was dominant in increasing plant height, effective tillers plant^{-1} and spike length. The effect of B was dominant in increasing grain number spike^{-1}. Combined application of S, Zn and B was apparently better in improving the plant characters.

Table 1

Effect of S, Zn and B application on yield contributing characters of wheat

Treatment	Plant height (cm)	Effective tillers plant^{-1} (No.)	Spike length (cm)	Grains spike^{-1} (No.)	1000-Grain wt (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Control	86.06 c	2.23 c	8.47 d	28.06 e	36.85 b	18.16 d	42.99 e
S	91.32 ab	3.05 a	9.41 abc	30.55 cde	38.46 a	22.79 b	50.60 c
Zn	87.03 bc	2.92 ab	8.91 cd	30.09 de	38.21 a	20.42 c	45.28 de
B	86.53 bc	2.62 b	8.94 cd	34.09 abc	38.04 a	22.04 bc	43.51 de
S+Zn	92.73 a	3.20 a	9.68 ab	31.14 bcde	38.18 a	23.26 b	56.00 ab
S+B	92.02 a	3.11 a	9.41 abc	34.45 ab	38.12 a	24.00 ab	52.08 bc
Zn+B	90.41 abc	2.60 b	9.14 bc	32.72 abcd	38.07 a	23.24 b	48.76 cd
S+Zn+B	92.12 a	3.21 a	9.81 a	35.66 a	38.23 a	25.82 a	60.46 a
S.E.(±)	1.14	0.089	0.131	0.830	0.145	0.557	1.27

In a column the figure(s) having same letter(s) do not differ significantly at 5% level of probability; ns , not significant

Table 2

Effect of S, Zn and B application on nutrient content of wheat

Treatment	Grain			Straw		
	S (%)	Zn (mg kg^{-1})	B (mg kg^{-1})	S (%)	Zn (mg kg^{-1})	B (mg kg^{-1})
Control	0.149 b	29.32 d	10.50 d	0.152 e	13.67 cd	8.65 e
S	0.205 a	29.81 d	10.41 d	0.248 bc	13.81 cd	10.50 d
Zn	0.155 b	34.77 abc	11.85 cd	0.230 cd	16.11 bc	9.25 de
B	0.163 b	30.47 cd	15.32 a	0.241 c	13.30 d	14.38 bc
S+Zn	0.221 a	35.19 ab	12.37 bcd	0.284 a	16.54 b	10.51 d
S+B	0.204 a	31.71 bcd	14.90 ab	0.266 ab	13.41 d	15.47 ab
Zn+B	0.152 b	36.50 a	14.48 abc	0.212 d	18.30 ab	13.93 c
S+Zn+B	0.200 a	37.19 a	15.10 a	0.284 a	19.76 a	16.85a
S.E. (±)	0.008	1.351	0.852	0.007	0.755	0.492

In a column the figure(s) having same letter(s) do not differ significantly at 5% level of probability; ns , not significant

Table 3

Effect of S, Zn and B application on S, Zn and B uptake by wheat

Treatment	S (kg ha^{-1})			Zn (g ha^{-1})			B (g ha^{-1})		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Control	2.70 d	6.51 e	9.21 f	52 f	58 d	110 d	18 d	36 f	54 g
S	4.68 ab	12.45 cd	17.13 cd	67 e	69 c	136 b	23 cd	52 e	75 ef
Zn	3.19 cd	10.40 d	13.59 e	70 de	73 c	143 b	23 cd	41 f	64 fg
B	3.58 c	1047 d	14.05 de	66 e	57 d	123 cd	33 ab	62 cd	95 cd
S+Zn	5.12 a	15.89 ab	21.01 ab	81 bc	92 b	173 a	28 bc	58 de	86 de
S+B	4.36 b	13.87 bc	18.23 bc	75 cd	69 c	144 b	35 ab	81 b	116 b
Zn+B	3.54 c	10.31 d	13.85 e	84 b	88 b	172 a	33 ab	67 c	100 c
S+Zn+B	5.18 a	17.16 a	22.34 a	95 a	118 a	213 a	38 a	101 a	139 a
S.E. (±)	0.485	1.06	0.68	2.1	2.2	5.1	3.3	2.4	4.2

In a column the figure(s) having same letter(s) do not differ significantly at 5% level of probability; ns , not significant.

Table 4

Apparent recovery of added S, Zn and B by wheat

Treatment	S uptake (kg ha^{-1})	S recovery (% applied)	Treatment	Zn uptake (g ha^{-1})	Zn recovery (% applied)	Treatment	B uptake (g ha^{-1})	B recovery (% applied)
S	17.13	53.1	Zn	143	0.82	B	94	2.00
Control	6.51	-	Control	110	-	Control	54	-
S+Zn	21.01	37.1	Zn+S	173	0.93	B+S	116	2.05
Zn	13.59	-	S	136	-	S	75	-
S+B	18.23	20.9	Zn+B	172	1.23	B+Zn	100	1.80
B	14.05	-	B	123	-	Zn	64	-
S+Zn+B	22.34	42.5	Zn+S+B	213	1.73	B+S+Zn	139	2.65
Zn+B	13.85	-	S+B	144	-	S+Zn	86	-

S added @20 kg ha^{-1}; Zn added @4 kg ha^{-1}; B added @2 kg ha^{-1}

The levels of S, Zn and B in grain were significantly affected by the treatments (Table 2). The content of S, Zn and B in grain was higher when a particular nutrient was applied to the soil. The level of S in grain, depending on the treatment, varied from 0.149 to 0.221%, Zn from 29.32 to 37.19 mg kg^{-1} and B from 10.41 to 15.32 mg kg^{-1}.

Like grain, there was a significant increase in the contents of S, Zn and B in straw (Table 2). The contents of S and Zn were higher in grain than those in straw. Sulphur content in straw varied from 0.152 to 0.284%, Zn from 13.30 to 19.76 mg kg^{-1} and B from 8.65 to 16.85 mg kg^{-1}.

Total nutrient uptake which was the sum of grain and straw uptake was also significantly affected by the treatments (Table 3). Apparently the uptake of S, Zn and B was higher by straw than that by grain. The uptake of B by grain was higher than that by straw. Total uptake of nutrients was found to be the highest in the S+Zn+B. Total uptake of S ranged from 9.21 to 22.34 kg ha^{-1}, Zn from 110 to 213 g ha^{-1} and B from 54 to 139 g ha^{-1}.

Apparent recovery of added nutrients presented in Table 4 shows that the recovery of S by wheat was the highest as compared to that of Zn and B. The percentage of apparent recovery of applied S in different treatments range from 20.0 to 53.1%; that of Zn from 0.82 to 1.73% and of B from 1.80 to 2.65%.

The present study indicates that for efficient production of wheat in Bangladesh, application of S, Zn and B is essential and that a major portion of the applied S, Zn and B remained in soil after harvest of wheat.

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