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Influence of sulphur, boron and zinc on garlic yield in Gangachara soil series

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Abstract

Field experiments were conducted to study the response of garlic *cv.* Multiclove local to different combinations of S, B, Zn and cowdung (CD) with NPK in the Gangachara soil series of Tista Meander Floodplain, Rangpur in two consecutive years. There was a significant influence of fertilizers on yield attributes and yield of garlic. The results were consistent over the years. NPK were more effective in combination with S and B in increasing the bulb yield. Zinc had no significant effect on bulb yield. The highest profitable bulb yield (5.75 t/ha) was produced by the combined application of NPKSBZn with the maximum benefit and the highest marginal rate of return (2741%). The effects of NPKSB, NPKSB+CD and NPKSBZn+CD on bulb yield and economic return were, however, statistically similar to NPKSBZn. For sustainace of soil health with higher yield, application of fertilizer along with organic manure like NPKSB+CD is important.

Keywords: Garlic, Sulphur, Boron and Zinc

Introduction

Garlic (*Allium sativum* L.) is an important spice crop grown all over Bangladesh during the winter season. Its average yield is 2.95 t/ha which is quite low compared to 6.3 t/ha (Anonymous, 2000) as world average. The reasons for low yields are mainly attributed to the use of low yielding variety, inadequate fertilizer application and improper cultural practices. It was observed in a number of experiments that N,P,K and S increased the bulb yield of garlic considerably (Shahidullah *et al.*, 1990 and Anwar *et al.*, 1996). Among micronutrients, B and Zn have received the maximum attention in soil and crop research. Information regarding the fertilizer requirement of garlic in the Tista Meander Floodplain soil (AEZ 3) is inadequite. Thus, the present study was undertaken to find out the effect of S, B and Zn along with NPK and CD on growth and bulb yield of garlic in the Gangachara soil series of Tista Meander Floodplain.

Materials and Methods

Experiments were conducted at the Sub-station farm of Bangladesh Institute of Nuclear Agriculture, Rangpur during Rabi seasons of 1999-2000 and 2000-2001. The soil was sandy loam belonging to Gangachara soil series of Tista Meander Floodplain (AEZ 3). Some important properties of the experimental field prior to the application of fertilizer were analyzed. Chemical characteristics of soil were determined by Hunter Method (1984). The soil was slightly acidic (pH 6.0), low in fertility status having organic matter 0.90%, available NH_4-N 65 µg/g, phosphorus 18 µg/g, potassium 0.15 meq/100 g, available sulphur 10.0 µg/g, boron 0.16 µg/g and zinc 1.6 µg/g.

The experiments were laid out in a randomized complete block design with three replications. The unit plot size was 2 m x 2 m with a plant spacing of 15 cm x 15 cm. The treatment consisted of 12 combinations with N,P,K,S,B,Zn and CD (cowdung) in the form urea, triple superphosphate, muriate of potash, gypsum, borax, zinc sulphate and cowdung @ 220, 210, 240, 110, 19, 9 and 5000 kg/ha, respectively. The whole amount of triple super phosphate, muriate of potash, gypsum, borax, zinc sulphate and cowdung, and one-third urea were applied at the time of final land preparation. The remaining urea was applied in two equal instalments in the 3rd and 5th weeks after planting followed by irrigation. The treatment combinations are presented in Table 1. The cloves of tested variety (Multiclove-local) were planted on 8 December and harvested on 10 April in both years. Irrigation and intercultural operations such as weeding and mulching were done as and when necessary. Data on vegetative growth and yield contributing characters were recorded from 10 sample plants in each plot. The sample plants were selected at random, leaving the boarder lines and the whole plot was harvested for bulb yield. The data were analyzed following standard statistical procedure and the means were compared following DMRT.

Partial budget analysis and marginal analysis of undominated fertilizer respones to bulb yield on average of two years were done following Elias and Karim (1984). The cost of fertilizer and gross return were calculated considering the following rates of fertilizers and bulbs: Tk. 6/kg urea; Tk. 14/kg TSP; Tk. 10/kg MP; TK. 4/kg Gypsum; TK. 50/kg $ZnSO_4$; Tk. 50/kg borax; Tk. 0.50/kg cowdung and bulb of garlic Tk. 25/kg.

Results and Discussion

Data on growth parameters of garlic plant are presented in Table 1. Different combinations of fertilizer treatments increased significantly the plant height, pseudostem diameter and leaf length over control in both the years (except NPKZn). The maximum plant height (57.3 cm), stem diameter (0.99 cm) and leaf length (37.1 cm) were recorded where NPKSBZn+CD was applied and it was followed by NPKSB+CD, NPKSBZn and NPKSB with an equal statistical rank. Interestingly, the fertilizer combination including boron always demonstrated higher growth performances than other fertilizer combinations. It indicates that boron had highly positive influence on plant growth. The shortest plant height and smallest diameter were recorded in control while leaf length was the lowest in NPKZn combination. The NPKZn treatment, was found statistical similar to control in case of plant height, pseudostem diameter and leaf length indicating Zn has no significant positive influence on plant growth. There was no significant differences in number of leaves per plant due to different fertilizers` use.

The yield and yield contributing parameters are presented in Table 2. The clove number per bulb, 100-clove weight, diameter of bulb and bulb yield increased significantly due to different fertilizers over control in both the years. Among the treatment combinations of different fertilizers, the fertilizer combination including boron always showed better performance on the different yield contributing characters. Within the boron added nutrient combinations, the maximum clove number per bulb and bulb diameter were observed in NPKSBZn combination with same statistical rank of other boron added nutrient combinations except NPKB where S was not present. It means boron is more effective in the presence of sulphur. The highest clove size was observed in NPKSB treatment followed by NPKSB+CD, NPKSBZn and NPKSBZn+CD with same statistical rank. In respect of bulb size, boron along with N,P,K,S,Zn and CD demonstrated superior performance.

Table 1. Effects of chemical fertilizers and cowdung on growth of garlic at BINA farm, Rangpur during 1999-2000 and 2000-2001

Treatments	Plant height (cm)			Psedostem diameter (cm)			Leaf length (cm)			Leaves/
	1999-2000	2000-2001	Mean	1999-2000	2000-2001	Mean	1999-2000	2000-2001	Mean	plant (No.) (1999-2000)
NPK (Control)	44.8 c	40.9 d	42.8 d	0.70 c	0.60 c	0.65 c	30.0 d	29.6 c	29.8 d	8 ns
NPKS	44.8 c	44.3 b	44.5 d	0.85 b	0.87 a	0.86 b	31.4 d	30.9 bc	31.1 cd	8
NPKB	46.7 c	43.1 c	44.9 d	0.90 b	0.86 a	0.88 b	33.8 c	32.1 b	33.0 bc	8
NPKZn	44.4 cd	41.2 d	42.8 d	0.83 b	0.82 b	0.82 b	29.9 d	27.5 d	28.7 d	8
NPKSB	60.4 a	49.7 a	55.0 a	0.97 a	0.87 a	0.92 a	37.8 ab	34.1 a	36.0 a	9
NPKSZn	44.7 c	43.3 c	44.0 d	0.90 b	0.82 b	0.86 b	30.3 d	30.0 c	30.1 d	8
NPKSBZn	63.4 a	48.0 ab	55.7 a	0.99 a	0.90 a	0.94 a	37.3 b	33.7 a	35.5 a	9
NPK+CD	54.8 b	43.2 c	49.0 c	0.75 c	0.83 b	0.79 b	33.8 c	31.5 b	32.7 c	8
NPKS+CD	55.5 b	44.0 b	49.8 c	0.78 c	0.82 b	0.80 b	34.1 c	31.3 b	32.7 c	8
NPKSB+CD	63.7 a	49.3 a	56.5 a	0.95 a	0.86 a	0.90 ab	37.7 ab	35.0 a	36.4 a	9
NPKSZn+CD	62.4 a	45.6 b	54.0 b	0.85 b	0.79 b	0.82 b	36.8 b	32.7 b	34.7 b	9
NPKSBZn+CD	63.6 a	51.3 a	57.5 a	1.06 a	0.92 a	0.99 a	39.9 a	34.3 a	37.1 a	9
CV (%)	5.35	4.45	5.40	6.80	6.10	6.55	5.63	4.35	5.00	3.71
S. E. ±	0.66	0.56	0.77	0.03	0.02	0.025	0.62	0.42	0.52	0.12

In a column, figures bearing same letter(s) do not differ significantly at 5% level by DMRT.
CD = Cowdung

Table 2. Effects of chemical fertilizers and cowdung on the yield contributing characters and yield of garlic at BINA farm, Rangpur during 1999-2000 and 2000-2001

Treatments	Cloves/bulb (No.)			100- clove weight (g)			Bulb diameter (cm)			Bulb yield (t/ha)			Yield increase over control (%)
	1999 - 2000	2000 - 2001	Mean	1999 - 2000	2000 - 2001	Mean	1999 - 2000	2000 - 2001	Mean	1999 - 2000	2000 - 2001	Mean	
NPK (Control)	18.8 d	17.8 c	18.3 e	63.00 f	63.33 d	61.67 e	3.18 c	3.09 c	3.13 d	4.52 d	4.37 c	4.45 d	----
NPKS	21.0 c	22.6 a	21.8 c	71.67 e	64.67 d	68.17 d	3.06 c	3.42 b	3.24 c	4.50 d	4.86 b	4.68 cd	5.20
NPKB	24.2 b	23.7 a	23.9 b	85.67 c	83.00 a	84.33 b	3.43 b	3.43 b	3.43 b	5.24 b	4.97 b	5.11 b	14.8
NPKZn	22.0 c	20.0 b	21.0 c	76.67 d	71.00 c	73.83 c	3.40 b	3.25 c	3.32 c	4.75 c	4.46 c	4.61 cd	3.60
NPKSB	23.4 b	22.4 a	22.9 b	103.3 a	83.67 a	93.50 a	3.69 a	3.44 b	3.57 a	6.01 a	5.20 a	5.61 ab	26.1
NPKSZn	21.1 c	20.4 b	20.7 d	72.00 e	67.33 c	69.67 c	3.47 b	3.33 b	3.40 b	5.11 c	4.70 b	4.91 b	10.3
NPKSBZn	26.8 a	24.3 a	25.5 a	99.00 a	81.00 a	90.00 a	3.80 a	3.61 a	3.71 a	6.26 a	5.24 a	5.75 a	29.2
NPK+CD	21.8 c	22.0 a	22.4 c	84.61 c	72.28 c	78.44 bc	3.47 b	3.42 b	3.45 b	4.85 c	4.90 b	4.88 bc	12.8
NPKS+CD	21.9 c	22.9 a	22.4 c	84.73 c	78.00 b	81.37 b	3.48 b	3.53 a	3.50 b	4.88 c	5.15 a	5.02 b	9.40
NPKSB+CD	24.1 b	22.0 a	23.0 b	101.7 a	83.33 a	92.50 a	3.76 a	3.63 a	3.70 a	6.32 a	5.11 ab	5.72 a	28.5
NPKSZn+CD	22.1 c	22.2 a	22.1 c	82.33 c	77.00 b	79.67 b	3.57 a	3.46 b	3.52 b	4.97 c	4.68 bc	4.83 c	8.50
NPKSBZn+CD	24.3 b	22.0 a	23.0 b	95.00 b	83.00 a	89.00 a	3.79 a	3.60 a	3.70 a	6.14 a	5.29 a	5.72 a	28.5
CV (%)	5.30	6.60	6.00	6.00	5.50	6.90	5.10	5.60	5.40	7.53	7.00	7.40	
S. E. ±	0.48	0.69	0.57	1.97	1.69	2.21	0.05	0.06	0.06	0.04	0.037	0.04	

In a column, figures bearing same letter(s) do not differ significantly at 5% level by DMRT
CD = Cowdung

Higher bulb yield was observed in all boron added treatments in both years. Among the treatments, the NPKSBZn performed the best (5.75 t/ha) followed by NPKSB+CD (5.72 t/ha), NPKSBZn+CD (5.72 t/ha) and NPKSB (5.61 t/ha) with same statistical rank (Table 2). In contrast, control (NPK only) treatment performed the lowest.

The individual effect of S and B on yield and yield contributing characters had significant influence over control (Table 2). But Zn had no significant influence on yield. Anwar *et al.* (1996) reported that Zn had hardly an effect on bulb yield of garlic. Nasreen and Islam (2000) also reported the same opinion regarding the effect of Zn on onion. Boron had significant positive effect on yield and yield contributing characters. Increase in bulb yield due to added sulphur has been reported by several workers (Anwar *et al*, 1996 and Alam *et al*, 1999). In the present experimental results, in general, it was observed that the combined effect of S and B in presence of NPK had positive influence on growth, yield contributing characters and yield of garlic.

The bulb yields by increased 26.1-29.2% over control (NPK only), in the nutrients combination of NPKSB, NPKSBZn, NPKSB+CD and NPKSBZn+CD, of which NPKSBZn performed the best. On the other hand, NPKZn nutrient combination had no significant difference over control (Table 2).

It was observed that application of different combination of N, P, K, S, B, Zn and CD had positive effect on economic return over control (Table 3). Among different combination of nutrients, boron added nutrient combinations (*viz.* NPKB, NPKSBZn, NPKSB and NPKSBZn+CD) resulted in higher benefit compared to other nutrient combinations and benefit increased 26.4 - 29.3% over control. Among boron added nutrient combinations, NPKSBZn had the highest benefit which was identical to other boron added treatments. Marginal analysis of undominated fertilizer response data (Table 4) recorded the highest marginal rate of return (2741%) in NPKSB followed by NPKB (2008%) treatment. It may be concluded that for garlic cultivation, the marginal farmers` may be advised to follow NPKSB treatment. The farmers having ability to invest more, may go for treatment of NPKSB+CD for maximum economic benefit and also sustainable soil health.

Table 3. Partial budget analysis for fertilizers use in bulb yield of garlic (average of two years)

Treatments	Economic yield (t/ha)	Gross profit (Tk./ha)	Variable cost (Tk./ha)	Gross margin (Tk./ha)	Benefit increase in percentage over control
NPK (Control)	4.45	1,11,250	6,660	1,04,590	----
NPKS	4.68	1,17,000	7,100	1,09,900	5.10
NPKB	5.11	1,27,750	7,610	1,20,140	14.9
NPKZn	4.61	1,15,250	7,110	1,08,140	3.40
NPKSB	5.61	1,40,250	8,050	1,32,200	26.4
NPKSZn	4.91	1,22,750	7,550	1,15,200	10.1
NPKSBZn	5.75	1,42,750	8,500	1,35,250	29.3
NPK+CD	4.88	1,22,000	8,160	1,13,840	8.80
NPKS+CD	5.02	1,25,500	8,600	1,16,900	11.4
NPKSB+CD	5.72	1,43,000	9,560	1,33,440	27.6
NPKSZn+CD	4.83	1,20,750	9,050	1,11,700	6.80
NPKSBZn+CD	5.72	1,43,000	10,000	1,33,000	27.2

Table 4. Marginal analysis of undominated fertilizers response of bulb yield of garlic (average of two years)

Treatments	Gross margin (Tk./ha)	Variable cost (Tk./ha)	Marginal increase in gross margin (Tk/ha)	Marginal increase in variable cost (Tk/ha)	Marginal rate of return (%)
NPKSBZn	1,35,260	8,500	3,060	450	680
NPKSB	1,32,200	8,050	12,060	440	2741
NPKB	1,20,140	7,610	10,240	510	2008
NPKS	1,09,900	7,100	5,310	440	1207
NPK	1,04,590	6,660	----	---	----

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