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NUTRIENT UPTAKE AND YIELD OF ONION AS INFLUENCED BY NITROGEN AND SULPHUR FERTILIZATION

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Abstract

The effect of nitrogen (0, 80, 120, and 160 kg/ha from urea) and sulphur (0, 20, 40, and 60 kg/ha from gypsum) fertilization on N and S uptake and yield performance of onion (var. BARI Piaz-1) was studied in the research field of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during *rabi* seasons of 2002-2003 and 2003-2004. The experiment was laid out in a randomized complete block design under factorial arrangement with three replications. Addition of nitrogen and sulphur fertilizers exerted significant influence on the number of leaves/plant, plant height, diameter of bulb, single bulb weight, and yield of onion. The uptake of N and S by bulb also significantly responded to the application of nitrogen and sulphur. The highest yield of onion and the maximum uptake of N and S were recorded by the combined application of 120 kg N and 40 kg S/ha with a blanket dose of 90 kg P_2O_5, 90 kg K_2O, and 5 kg Zn/ha plus 5 tons of cowdung/ha. The antagonistic effect of nitrogen and sulphur on the uptake of N and S by bulb, yield components, and yield of onion was observed only when they were applied together at higher rates of nitrogen (160 kg/ha) and sulphur (40kg/ha).

Key Words**:** Nutrient uptake, yield of onion, influenced and sulphur.

Introduction

Onion (*Allium cepa* L.) is one of most important crops among the spices in Bangladesh. It is used in almost all food preparation and is an integral part of Bangladesh diet (Hossain and Islam, 1994). It is grown extensively during winter season in Bangladesh, occupying the first position both in area (31, 6160 ha) and production (27,2000 m tons) (BBS, 2005). It is grown in more or less in all the districts of the country, however, the average yield is 524 t/ha, which is very low as compared to many other onion producing countries of the world. The average world production is about 15 t/ha (FAO, 1999). There is an acute shortage of onion in relation to is requirement. This necessiates an improvement of per hectare yield, which is possible through adoption of high yielding varieties and

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judicious application of fetilizer. Concerning fertilizer application, nitrogen and sulphur are important since these two elements are highly deficient in this country's soils. Onion responded to N and S positively in terms of yield and quality of bulbs (Patel and Patel, 1990; Vachhani and Patel, 1993). Sulphur is essential for building up sulphur containing amino acids and also for a good vegetative growth and bulb development in onion (Anwar *et al.,* 2001). Research information regarding the nitrogen and sulphur requirement for onion production in Bangladesh is insufficient or sporadic. In view of this, the present experiment was undertaken to assess the effect of different rates of nitrogen and sulphur fertilizers on the N and S uptake and yield performance of onion.

Materials and Method

A field experiment was conducted at the farm of the Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur during two consecutive *rabi* seasons of 2002-2003 and 2003-2004. The soil is silty clay loam belonging to Chhiata series of Grey Terrace soil (Aeric Albaquept). The initial soil samples collected from a depth of 20 cm were analyzed by ASI method (Hunter, 1984) and the properties are presented in Table 1. The soil is slightly acidic in reaction (pH 6.0) with a low content of organic matter (1.05%), total N (0.05%), available P (10 μg/g, available S (9 μg/g) and exchangeable K (0, 18 meq/100 g soil).

Four levels of nitrogen (0, 80, 120, and 160 kg N/ha from urea) and four levels of sulphur (0, 20, 40, and 60 kg S/ha from gypsum) were the treatment variables. The trial was set up in a randomized complete block design under factorial arrangement with three replications. A blanket dose of 90 kg P_2O_5, 90 K_2O, and 5 kg Zn/ha were used in the form of triple superphosphate, muriate of potash, and zinc oxide, respectively. Cowdung at the rate of 5 t/ha was used in all the plots. Unit plot size was 3m × 4m. Full doses of gypsum, triple superphosphate, muriate of potash, zinc oxide, cowdung and 1/3rd of urea were applied in the time of final land preparation. The remaining urea was top dressed in two equal instalments after third and sixth week of transplanting. The variety BARI Piaz-1 was used as a test crop. Forty-five day old seedlings were transplanted on 15 December in 2002 and 14 December in 2003 at a spacing of 20cm × 10cm. Mulching, weeding, and irrigation were done and plant protection measures were taken whenever required.

At maturity, five plants (i.e., bulbs) from each plot were collected randomly to determine dry matter accumulation. These samples were dried at 70°C in oven until a constant weight was attained. These dry bulbs were used for the estimation of N and S contents. Nitrogen content in bulb was determined by modified Kjeldahl digestion method (Yamakawa, 1993) and sulphur content was determined by ASI method (Hunter, 1984). Nitrogen and sulphur uptake was

estimated as the dry matter multiplied by nitrogen and sulphur contents (%). Another ten randomly selected plants were harvested from each plot to record the data on bulb diameter and bulb weight. The crop was harvested on 12 April in 2003 and 10 April in 2004. Bulb yield was recorded from an area of 6 m^2 from each plot avoiding border effect. The data were then statistically analyzed and means were compared by using the least significant difference (LSD) test.

Results and Discussion

Yield attributes

Nitrogen had a significant effect on the yield attributes of onion in both the years (Table 1). Application of 120 kg N/ha increased the number of leaves/plant and plant height significantly over the control as well as lower levels of nitrogen. Further increase in the level of nitrogen (160 kg/ha) tended to decrease the number of leaves/plant and plant height. Nitrogen also influenced the size and weight of bulbs. There was significant increase in diameter and weight of bulbs due to application of nitrogen upto 120 kg/ha and thereafter decreased. The size of bulb varied from 4.0 to 4.9 cm in 2002-2003 and 4.2 to 4.8 cm in 2003-2004 due to nitrogen application. The weight of bulb was increased by 24.1 and 33.6% in 2002-2003 and 25.4 and 41/7% in 2003-2004 with 80 and 120 kg N/ha, respectively, over no nitrogen application. Sulphur fertilizer application also exerted significant influence on number of leaves/plant, plant height, bulb size, and weight of onion in both the years (Table 2). Plant height increased almost linearly with increasing S reaching the maximum at 40 kg S/ha and thereafter decreased. Application of sulphur increased the number of leaves/plant and was more with 40 kg S/ha and lowest at 0 kg S/ha in both the years. The diameter and weight of bulbs were significantly increased with the application of sulphur upto 40 kg/ha and then decreased. However, weight of bulbs increased by 18.7 and 32.1% in 2002-2003 and 24.3 and 40.7% in 2003-2004 with 20 and 40 kg S/ha as compared to without sulphur application.

Table 1. Effect of nitrogen application on the number of levels/plant, plant height diameter of bulb and single bulb weight of onion in 2002-2003 and 2003-2004.

N levels (kg/ha)	Leaves/plant (no.)		Plant height (cm)		Diameter of bulb (cm)		Single bulb wt (g)	
	2002-2003	2003-3004	2002-2003	2003-3004	2002-2003	2003-3004	2002-2003	2003-3004
0	11.7	11.5	41.2	43.3	4.0	4.2	33.32	32.94
80	13.9	12.1	45.7	46.5	4.5	4.5	41.35	41.32
120	14.8	13.8	49.2	49.3	4.9	4.8	44.50	46.66
160	13.6	13.4	48.6	48.6	4.7	4.6	44.44	46.23
LSD 0.05	0.6	0.4	1.1	1.0	0.2	0.2	1.73	2.29

Table 2. Effect of sulphur application on the number of levels/plant, plant height diameter of bulb and single bulb weight of onion in 2002-2003 and 2003-2004.

S levels (kg/ha)	Leaves/plant (no.)		Plant height (cm)		Diameter of bulb (cm)		Single bulb weight (g)	
	2002-2003	2003-3004	2002-2003	2003-3004	2002-2003	2003-3004	2002-2003	2003-3004
0	11.6	10.1	41.4	39.8	4.1	3.6	35.08	33.13
20	14.0	11.8	46.6	46.5	4.6	4.5	41.64	41.18
40	14.8	13.0	50.5	51.5	5.0	5.1	46.30	46.61
60	14.6	13.0	52.2	50.0	5.0	4.9	46.21	46.44
LSD 0.05	0.6	0.4	1.1	1.0	0.2	0.2	1.73	2.29

Bulb yield

Application of nitrogen fertilizer increased the bulb yield on onion significantly (Table 3). Increasing nitrogen levels from 0 to 120 kg/ha resulted in progressive increase in bulb yield of onion. Similar result was also reported by Anwar *et al.* (2001) for onion. Further increase in nitrogen fertilizer (160 kg/ha) tended to depress bulb yield. Plants grown without nitrogen fertilizer had the lowest bulb yield. The yield difference between the highest and the lowest yielding treatments was 62%. Yield of onion was also significantly affected by the application of sulphur. It was observed that bulb yield was increased with successive increase in the levels of sulphur upto 40 kg/ha and thereafter decreased. Application of 40 kg S/ha gave 70 and 20% in 2002-2003 and 58 and 19.1% in 2003-2004 higher bulb yield over no or 20 kg S/ha. Peterson (1979) also reported the increase in bulb yield with increase in sulphur level in onion and Singh *et al.* (1995) in garlic. It appears that there was a quantum jump in bulb yield due to fertilizer application suggesting that the soil was deficient in nitrogen and sulphur that resulted in a big yield differences even with 80 kg N or 20kg S/ha application. This yield increase was due to the increase in bulb size and weight. Plants grown without added sulphur produced consistently lowest bulb. This result thus suggested that sulphur deficiency has adverse effect on growth and yield of onion.

There was no significant interaction effect of nitrogen and sulphur for any of the characters under study except bulb yield in the years (Table 3). However, yield of onion varied from 6.60 to 17.18 t/ha in 2002-2003 and 6.80 to 17.22 t/ha in 2003-2004 due to different nitrogen and sulphur levels. At every rate of sulphur application, onion responded to nitrogen upto 120 kg/ha. Thus combined application of nitrogen and sulphur upto 120 kg N and 40 kg S/ha showed a significant synergistic effect on the bulb yield of onion in both years. Further addition of nitrogen (160 kg/ha) and sulphur (60 kg/ha) decreased the yield of onion. This might have an imbalance or antagonistic effect on plant nutrition that resulted in lower yield.

N and S uptake

The uptake of N by onion bulb varied significantly due to different doses of nitrogen application in both the years (Table 4). Uptake of N by onion bulb increased progressively with added N fertilizer upto 120 kg/ha and there was a reduction in uptake with 160 kg N/ha. Significantly the lowest N uptake was noted in onion bulb with 0 kg N/ha. N uptake by onion bulb also differed significantly due to variation of sulphur levels. Uptake of N by bulbs varied

Table 3. Effect of nitrogen and sulphur application on the yield of of onion (t/ha) in 2002-2003 and 2003-2004.

S levels (kg/ha)	2002-2003					2003-2004				
	0	80	120	160	Mean	0	80	120	160	Mean
0	6.60	8.46	10.26	10.05	8.84	6.80	8.93	11.08	9.05	8.74
20	8.69	12.53	14.54	14.40	12.54	8.57	12.77	14.63	14.55	12.63
40	10.66	15.43	17.18	16.77	15.01	10.80	15.33	17.22	16.84	15.05
60	10.50	15.16	16.88	16.59	14.53	10.66	15.10	16.99	16.84	15.05
Mean	9.11	12.90	14.72	14.20	-	9.21	13.03	14.76	14.23	-
LSD 0.05 for :										
Nitrogen (N)			0.66					0.58		
Sulphur (S)			0.66					0.58		
N × S			1.75					1.80		

Table 4. Effect of Nitrogen and sulphur application on N uptake (kg/ha) by bulb in 2002-2003 and 2003-2004.

S levels (kg/ha)	2002-2003					2003-2004				
	0	80	120	160	Mean	0	80	120	160	Mean
0	165	220	260	251	224	175	227	299	290	284
20	258	300	355	342	314	265	319	377	368	332
40	360	404	475	435	419	372	424	495	442	433
60	352	396	430	432	403	362	415	446	430	413
Mean	284	330	380	365	-	294	316	404	383	-
LSD 0.05 for :										
Nitrogen (N)			0.66					0.58		
Sulphur (S)			0.66					0.58		
N × S			1.75					1.80		

Table 5. Effect of nitrogen and sulphur application on S uptake (kg/ha) by onion bulb in 2002-2003 and 2003-2004.

S levels (kg/ha)	2002-2003					2003-2004				
	0	80	120	160	Mean	0	80	120	160	Mean
0	14	22	31	28	24	17	26	35	34	28
20	29	40	51	49	42	31	43	54	52	45
40	43	51	60	56	53	45	55	64	59	56
60	40	50	56	53	47	43	53	59	56	53
Mean	29	41	50	47	-	34	44	53	50	-
LSD 0.05 for :										
Nitrogen (N)			6					5		
Sulphur (S)			6					5		
N × S			7					8		

from 224 to 419 kg/ha in 2002-2003 and 248 to 433 kg/ha in 2003-2004 due to different sulphur levels. There was almost a liner increase in N uptake with the increased rate of sulphur application upto 40 kg/ha and further increase in sulphur application decreased the N uptake. These results are in conformity with the findings of Singh *et al.* (1995). The interaction effect of nitrogen and sulphur on N uptake by the bulb was significant and the maximum value of N uptake was recorded with 120 kg N/ha and 40 kg S/ha (Table 4). The combined effect of nitrogen and sulphur on N uptake was found to be synergistic. Further increase of nitrogen (160 kg/ha) and sulphur (60 kg/ha) tended to decrease the N uptake by onion bulb. S uptake by onion bulb followed the pattern similar to that obtained for N uptake (Table 5). Fertilizer nitrogen and sulphur might have promoted the availability of native soil N and S as reflected by their uptake.

Conclusion

Application of 120 kg N and 40 kg S/ha along with 90 kg P_2O_5, 90 kg K_2O and 5 kg Zn/ha plus 5 tons cowdung/ha might be an optimum combination for onion production in Grey Terrace Soil (Aeric Albaquept) Chhiata series (Agro-ecological zone-28) at Joydebpur, Gazipur.

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