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RESPONSE OF VARYING LEVELS OF POTASSIUM AND SULPHUR ON YIELD AND UPTAKE OF NUTRIENTS BY ONION

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ABSTRACT

Field experiments were conducted at Lakhaoti, Bulandshahr (U.P.) during rabi seasons of 2008-09 and 2009-10 to study the effect of potassium and sulphur on yield and uptake of nutrients by onion. The treatments consisted of four levels of K (0, 30, 60 and 90 kg K_2O ha^{-1}) and S (0, 20, 40 and 60 kg ha^{-1}) Results revealed that fresh weight per bulb, bulb and dry matter yield increased significantly with increasing levels of K and S individually as well as in various combinations. Application of K and S increased the content and yield of protein in onion bulbs. The uptake of nutrients, (N, P, K and S) increased significantly with increasing levels of K and S. The synergistic effect of K and S levels was observed on yield and uptake of K and S by onion bulb.
Keywords: Potassium, sulphur, interaction, yield, nutrient uptake, onion.

INTRODUCTION

Onion (*Allium cepa* L.) is one of the most important bulb crops of India. The average yield of onion in India is about 12.8 t ha^{-1} which is very low when compared with the global average of 17.2 t ha^{-1} (Anonymous 2010). The existing low yield of onion is mainly because of the sub-optimal soil fertility. Potassium plays an important role in the production of bulbous crops like onion (Pachauri et al. 2005). In addition to its major role in metabolic processes, potassium improves the quality of produce, imparts resistance to pests and diseases and tolerance to cold and forest. The onion responds to sulphur application (Singh et al. 1996). Sulphur is essential for synthesis of proteins, vitamins and sulphur containing essential amino acids and is also associated with nitrogen metabolism. Sulphur improved both yield and quality of the crops. Deficiency of sulphur is increasing due to continuous use of S-free fertilizers and increasing cropping intensity with high yielding cultivars and is more conspicuous in light textured soils low in organic matter. The interaction of these nutrient elements may affect the critical levels of available K and S below which response to their application could be observed. Information on effect of combined application of K and S on yield quality and uptake of nutrients in onion is rather limited. Therefore, the present study was initialed to study the effect of K and S application on yield and uptake of nutrients by onion in sandy loam soil.

MATERIALS AND METHODS

The field experiment was conducted during 2008-09 and 2009-10 at research farm, Amar Singh College, Lakhaoti, Bulandshahr (U.P.). The soil of the experimental field was sandy loam in texture, low in available N (185.0 kg ha^{-1}), P (9.0 kg ha^{-1}) and K (105.0 kg ha^{-1}). The experiment comprising four levels each of potassium (0, 30, 60 and 90 kg ha^{-1}) and sulphur (0, 20, 40 and 60 kg ha^{-1}) was conducted in a randomized block design with three replications. The doses of K and S as per treatments were supplied through muriate of potash and elemental sulphur, respectively at transplanting time. Recommended dose of N (150 kg N ha^{-1}) and P (100 kg P_2O_5 ha^{-1}) through urea and triple superphosphate was given as basal dressing. During transplanting, individual seedling was separated from clumb. The seedling was planted at 15 in to 10 cm spacing. Subsequent irrigation, weeding and plant protection measure were carried out as and when required. The onion crop was harvested at full maturity. The fresh weight of bulbs per plot was converted in to the yield of bulbs per hectare in tonnes. The bulb samples were collected for analysis of N, P, K and S. In ground bulb samples, nitrogen was estimated by Kjeldahl method. For P, K and S estimation, bulb samples were digested in a di acid mixture (HNO_3 and $HClO_4$) and P in the extract was determined by vanadomolybdate yellow colour method (Jackson 1973). Potassium and sulphur content in the same extract was determined by flame photometer and turbidi metric method (Chesnin and Yien 1951). Protein content was computed by multiplying the N content with 6.25.

RESULTS AND DISCUSSION

The fresh weight per bulb significantly increased from 48.6 to 61.0 g with 90 kg K_2O ha^{-1}. Potassium is supposed to be related with metabolism and translocation of carbohydrates in plants which ultimately might have increased the fresh weight of an individual bulb. Verma et al. (2010) reported similar results. The sulphur application also increased the fresh weight per bulb from 51.9 g at control to

58.0 g at 40 kg S ha^{-1}. The higher level of S (60 kg ha^{-1}) could not improve the fresh weight of bulb over 40 kg S ha^{-1}. However, the increases were significant as compared to control at each level of sulphur application. This might be ascribed adequate supply of sulphur that resulted in higher production of photosynthetic and their translocation to sink, which ultimately increased the fresh yield of bulb.

Table 1: Effect of K and S levels on yield and protein in onion bulbs

Treatments	Fresh weight/bulb (g)	Bulb yield (t ha^{-1})	Dry matter yield (t ha^{-1})	Protein content (%)	Protein yield (kg ha^{-1})
Potassium (kg ha^{-1})					
0	48.6	32.9	5.3	5.8	304.9
30	53.2	36.2	5.8	5.9	340.4
60	57.7	38.2	6.1	6.0	366.0
90	61.0	40.7	6.3	6.0	390.1
CD (P=0.05)	2.27	1.57	0.22	0.23	44.3
Sulphur (kg ha^{-1})					
0	51.9	33.4	5.4	5.7	307.8
20	55.5	36.2	5.7	5.9	336.9
40	58.0	38.6	6.1	6.0	370.5
60	55.2	39.7	6.3	6.1	390.8
CD (P=0.05)	2.27	1.57	0.22	0.23	44.3

The bulb and dry matter yields increased significantly with increasing level of potassium (Table 1). The percent increase in bulb yield due to K application varied from 10.0 to 23.7%, whereas the dry matter yield increased from 9.4 to 18.8%.. This increase in yield with application of potassium may be due to its favourable effect on both gro as well as yield parameters of onion. Pachauri et al. (2005) and Verma et al. (2010) reported similar results. Addition of graded doses of sulphur significantly improved the bulb yield of onion over control. Addition of 60 kg S ha^{-1} registered the highest bulb yield (39.7 t ha^{-1}). The percent increase in bulb yield due to application of 20, 40 and 60 kg S ha^{-1} over control was 8.4, 15.6 and 19.0%, respectively. The increase in bulb yield of onion in sulphur applied plots might be due to higher production of metabolites and increase in meristematic activity. Besides, it could be attributed to improvement in nutritional environment in crop root zone and ultimately resulted in better vegetative growth and finally the bulb yield. The soil low in sulphur was unable to supply the nutrient significantly for optimum growth and yield of crop. The increase in bulb yield was mainly due to enhanced rate of photosyntheses and carbohydrate metabolism as influenced by S application. Kumar and Singh (2004) reported enhanced bulb yield due to S application. The synergistic effect of potassium and sulphur interaction on bulb and dry matter yield was highest at 90 kg K_2O + 60 kg S ha^{-1} followed by 90 kg K_2O + 40 kg S ha^{-1} in bulb yield dry matter yield. The magnitude of increase in bulb and dry matter yield was 44.0 and 35.4% due to combined application of potassium and sulphur (90 kg K_2O + 60 kg S ha^{-1}) over control, respectively. The synergistic effect of K and S may be due to utilization of large quantities of nutrients by crop which might have resulted in better plant development and ultimately yield in medium K status and low S status in the experimental soil.

The content and yield of protein in onion bulb increased significantly with application of potassium. The maximum content (6.0%) and yield (390.1 kg ha^{-1}) of protein were obtained with 60 kg and 90 kg K_2O ha^{-1}, respectively. The response to applied K with respect to protein yield may be attributed to higher bulb production. Singh and Singh (1991) reported similar results. Application of sulphur levels resulted in significant increase in protein content and yield over control. The positive response to added sulphur is assigned to low status of available sulphur of soil or due to stimulating effect of a applied sulphur in the synthesis of chloroplast-protein resulting in greater photosynthetic efficiency which in turn translated in terms of increase in yield. Similar results were reported by Singh and Singh (2003).

Table 2: Effect of K and S levels on content and uptake of nutrients by onion

Treatments	Nutrient content (%)				Nutrient uptake (kg ha^{-1})			
	N	P	K	S	N	P	K	S
Potassium (kg ha^{-1})								
0	0.92	0.23	0.79	0.43	48.9	12.4	41.7	22.9
30	0.95	0.24	0.90	0.45	53.5	14.1	52.2	26.2
60	0.96	0.26	1.04	0.46	58.6	16.2	63.5	28.4
90	0.96	0.27	1.10	0.47	62.5	17.8	71.5	30.9
CD (P=0.05)	0.015	0.008	0.021	0.011	3.41	0.80	4.22	1.69
Sulphur (kg ha^{-1})								
0	0.91	0.22	0.93	0.38	49.3	12.1	50.1	20.7
20	0.94	0.25	0.98	0.43	53.9	14.6	54.8	25.2
40	0.96	0.26	0.97	0.49	59.3	16.3	59.6	30.1
60	0.98	0.27	0.98	0.51	62.6	17.5	62.6	32.4
CD (P=0.05)	0.015	0.008	0.021	0.011	3.41	0.80	4.22	1.69

The significant increase in content and uptake of N in onion bulbs was noticed with the application of increased levels of potassium and the highest content and uptake was noticed at 90 kg K_2O ha^{-1}. The mean nitrogen content in bulbs increased from 0.92% at control to 0.96% with 90 kg K_2O ha^{-1}. The N uptake which was 40.9 kg ha^{-1} at control increased to 62.5 kg ha^{-1} with the application of 90 kg K_2O ha^{-1}.

The increase in N uptake was mainly due to increase in yield. Similar results were reported by Singh and Singh (1991) and Rai et al. (2002). Application of S contributed to significant increase in content and uptake of N in onion bulbs. The mean N content in onion bulbs increased from 0.91 to 0.98% with increasing levels of S up to 60 kg ha^{-1}. The corresponding increase in N uptake by bulb was from 49.3 to 62.6 kg ha^{-1}. The improvement was mainly due to greater production of onion bulbs. Kumar and Singh (2004) also reported similar results.

Application of K increased P content in bulbs significantly over control indicating a synergistic effect of K on P nutrition of onion. Phosphorus uptake by onion bulbs increased significantly with K application over control. The maximum phosphorus uptake to the extent of 17.8 kg ha^{-1} by bulbs was observed with the application of 90 kg K_2O ha^{-1}. Similar results were reported by Singh et al (2009). Sulphur application increased P content from 0.22% at control to 0.27% at 60 kg S ha^{-1}. There was a significant increase in P uptake by bulb with S application and maximum value was recorded at 60 kg S ha^{-1}. The increase in P uptake was mainly due to greater bulb production and improved P content due to S addition. Singh and Singh (2003) reported similar results.

The content and uptake of K increased significantly with the increase in levels of applied potassium. Application of 90 kg K_2O ha-^{1} increased its content and uptake by onion bulbs from 0.79 to 1.10% and 41.7 to 71.5 kg ha-^{1}, respectively. The higher bulb yield of onion under higher K levels absorbed large quantities of K from the soil thus depleting the soil of more K consequently showing higher uptake in bulb. Sahota and Singh (1985) reported similar results. Sulphur addition also had significantly beneficial effect on absorption and utilization of K by onion bulbs and maximum values were recorded at 60 kg S ha-^{1}. Similar results were reported by Singh et al. (2009). Interaction effect between S and K had a significant effect on the uptake of K by onion bulbs. The maximum value of K uptake by bulbs was recorded under 90 kg K_2O+ 60 kg S ha-^{1} (Table 3).

Table 3: Interactive effect of K and S levels on yield and uptake of K and S by onion

Sulphur (kg ha^{-1})	Potassium (kg ha^{-1})				Potassium (kg ha^{-1})			
	0	30	60	90	0	30	60	90
	Bulb yield (t ha^{-1})				Dry matter (t ha^{-1})			
0	30.4	32.6	34.4	36.5	4.8	5.2	5.7	5.8
30	32.3	35.6	37.3	39.8	5.1	5.6	5.9	6.2
60	33.9	37.8	40.0	42.8	5.4	6.0	6.3	6.9
90	35.1	38.9	41.3	43.8	5.7	6.2	6.5	7.0
CD (P=0.05)	3.14				0.44			
	Potassium uptake (kg ha^{-1})				Sulphur uptake (kg ha^{-1})			
0	36.4	45.6	57.6	62.9	17.3	20.1	22.5	23.0
20	40.6	50.2	61.5	69.0	21.1	24.5	26.6	28.4
40	43.8	55.2	66.1	76.9	25.6	29.3	31.3	34.7
60	46.8	58.1	69.2	77.5	27.8	31.2	34.0	37.2
CD (P=0.05)	8.44				3.39			

Addition of K increased the mean S content in bulbs from 0.43 to 0.47% indicating sysrergistic effect on S nutrition (Rai et al. 2002). There was a significant increase in S uptake with K application over control. The increase in S uptake with K levels seems to be associated with increased S availability with a concomitant increase in crop yield. These results are in agreement with those reported by Rai et al.(2002). Application of S significantly increased its content and uptake over control. The mean S uptake by bulbs increased from 20.7 to 32.4 kg ha-^{1} Singh et al. (2001) reported similar results. The interaction of S and K was significant (Table3) in augmenting S uptake by bulb. The maximum value of S uptake was recorded with 60 kg S + 90 kg K_2O ha-^{1} and minimum in control.

It is concluded from the results that onion responds to potassium and sulphur fertilization and improves the productivity and quality of bulbs. Therefore, 90 kg K_2O ha-^{1} along with 40 kg S ha-^{1} should be applied in light textured soils for higher onion productivity in alluvial soils of Bulandshahr (U.P.).

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