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Sulphur nutrition affecting yield and quality in onion (*Allium cepa*)

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Abstract

In a two year (*rabi* 2000-2001 and 2001-2002) field study involving four S levels (0, 15, 30 and 60 kg/ha) through gypsum and S_{95} conducted on acid alfisols of Palampur (H.P.), bulb yield of onion increased significantly upto 30 kg/ha and quality parameters (TSS and Ascorbic acid) upto 60 kg S/ha. Gypsum proved superior over S_{95} in appreciating yield and quality. Nutrient (N, P and S) content and their ratios (N: S, S: P and N: P) in onion leaves at 63 days after transplantation (DAT) were found significantly and positively correlated with aforesaid quality parameters of onion.

Key words: Onion, sulphur, T.S.S., ascorbic acid, gypsum and S_{95} sulphur.

Introduction

Onion belonging to Liliaceae family, is typically an important S loving crop; where it improves not only the yield but also quality *i.e.* pungency, ascorbic acid content and total soluble solids (T.S.S.). Sulphur increases nitrogen and potassium utilization in plant system (Jaggi *et al.* 1995). Increased nitrogen triggers the activity of ascorbic acid oxidase enzyme resulting in the production of more ascorbic acid in onion. Similarly the increased potassium content favours more production and translocation of CHO during photosynthesis being a co-factor (Singh *et al.* 1989). Study by Kashi and Frodi (1998) also confirmed the positive effect of N and K on ascorbic acid and TSS in onion. Singh *et al.* (1992) observed increase in ascorbic acid content in onion with increasing concentration of applied N. As such, study was undertaken to study the effect of four S levels (0, 15, 30 and 60 kg ha^{-1}) through two sources *viz.* Gypsum and $Sulphur_{95}$ on two important quality parameters (Ascorbic acid and TSS) in onion.

Material and Methods

A field experiment was conducted with Onion (*Allium cepa* var. Patna red) during the winter season of 2000-2001 and 2001-2002 at Palampur, Himachal Pradesh. The soil of the experimental site was classified as an acid Alfisol (Typic Hepludalf) and had the following characteristics; Silty clay loam texture, pH 5.2, Organic C 1.36% and available N, P, K and S were 251, 36, 220 and 35 kg/ha, respectively. The treatments consisted of one control and three levels of S (15, 30 and 60 kg/ha) applied through Gypsum and S_{95}, in four replicates in Randomized Block Design having a plot size of 2.25 x 2.00 m^2. Total nitrogen, P_2O_5 and K_2O were applied basally @ 125, 33 and 50 kg ha^{-1}, respectively. Total phosphorus, part of K_2O and N were applied through IFFCO (12: 32: 16 mixture). Remaining N and K_2O were applied through urea and MOP, respectively. Half of N was added at transplanting time and remaining half in two equal splits approximately at 8 and 12 weeks intervals (depending upon soil moisture and plant growth) after the transplantation of onion seedlings, which was done in the second and fourth week of January in two years in respective manner. Crop was raised following standard package of practices and was harvested in the second week of June. Fresh weights of onion bulbs and foliage were taken separately and their samples were dried in the oven at 65 ± 5°C for moisture determination, crushed and stored for chemical analysis. Ascorbic acid content (%) in freshly harvested bulbs and total soluble solids (TSS) were determined by standard procedures. Available S and other nutrients in the soil were determined using standard procedures.

Results and Discussion

Sulphur application significantly increased bulb yield of onion; and total soluble solids (TSS) & ascorbic acid content therein over control in both years as well as on pooled basis (Table 1). Bulb yield was found significantly increased with S application at a rate of 30 kg ha^{-1} (169 % increase over control) over the previous level of 15 kg ha^{-1}. Further S level of 60 kg ha^{-1} did not affect the yield significantly.

Table 1. Sulphur levels and sources affecting yield and quality parameters in onion (Rabi 2000-01 and 2001-02)

Treatments	Bulb yield (t ha^{-1})			Ascorbic acid (%)			Total soluble solids (%)
	2000-2001	2001-2002	Pooled	2000-2001	2001-2002	Pooled	2000-2001
Control *vs* S application							
Control	8.8	4.2	6.5	9.7	10.2	10.0	8.4
S application	18.6	11.2	14.9	10.7	12.2	11.5	9.8
CD (P= 0.05)	5.71	5.83	3.94	0.84	1.51	1.32	0.55
S levels (kg ha^{-1})							
15	14.2	5.7	10.0	10.2	10.7	10.4	9.3
30	20.9	14.1	17.5 (169)*	10.9	12.2	11.6	9.8
60	20.7	13.9	17.3 (166)*	11.0	13.8	12.4	10.5
CD (P= 0.05)	5.29	5.40	3.65	NS	2.81	1.43	0.51
S sources							
Gypsum	19.8	13.5	16.6 (26)**	11.1	11.9	11.5	10.4
S_{95}	17.4	9.0	13.2	10.3	12.6	11.5	9.3
CD (P= 0.05)	NS	4.41	2.98	0.63	NS	NS	0.41

*Figures in parenthesis indicate % increase over no S

**Figures in parenthesis indicate % increase over S_{95} source

Findings were similar during both the years (*rabi* 2000-01 & 2001-02). Sulphur level of 60 kg ha^{-1} significantly increased the ascorbic acid content (%) over 15 kg ha^{-1}; but not over 30 kg ha^{-1}. Similarly, S level of 15 and 30 kg ha^{-1} also did not differ significantly between themselves in this respect. Findings were similar during *rabi* 2001-2002 and also in two year's pooled data (Table 1). Likewise different S levels too had significant effect on % TSS. Total soluble solids increased from 9.3% in treatment receiving 15 kg ha^{-1} to 10.5% where S was applied @ 60 kg ha^{-1}. The increase in TSS from 9.8 to 10.5 % with the application of 60 kg S/ha over 30 kg /ha was also statistically significant. The two S sources also differed significantly in affecting yield and quality parameters. Differences due to two sulphur sources (Gypsum and S_{95}) were not observed during the first year of experiment (*rabi* 2000-2001). However, during *rabi* 2001-2002 and also after pooling two years' data, Gypsum significantly out yielded (26% increase in the bulb yield over S_{95}) S_{95} (Table 1). Similarly, Gypsum proved superior to S_{95} in increasing ascorbic acid content and TSS in onion; though only during the first year (*rabi* 2000-2001). Sulphur is a constituent of secondary compounds (allin, cycloallin and thiopropanol) in Onion. The former governs the taste and medicinal properties of onion and garlic and the latter imparts pungency. This increases S requirements in onion. Therefore, the response to applied S is expected.

It is clear from the above discussion that quality parameters in onion improved only at higher S levels (60 kg ha^{-1}). On the other hand, yield and yield attributes were reported improved at lower S levels (Jaggi and Dixit, 1999; Jaggi, 2005). It means that physical attributes (yield and related parameters) take a priority over quality and subsequently nutrition is manifested on quality.

Finally an attempt was also made to correlate TSS (%) and Ascorbic acid (%) with nutrient content (N, P and S) and their ratios (N: S, S: P and N: P ratio) in onion leaves at 9 weeks after transplantation. Total soluble solids and Ascorbic acid were found significantly and positively correlated with N(r=0.85** and 0.70**) and S (r=0.78** and 0.54**) content; and N: S (r=0.52** and 0.57**), S: P (r=0.50** and 0.36**) and N: P (r=0.68** and 0.58**) ratios as indicated by the values of correlation coefficients in respective manner (Table 2).

Table 2. Correlations between quality parameters and nutrient content in onion leaves at 9 weeks after transplantation (*rabi* 2000-2002)

Quality parameter	Nutrient content (%) and their ratios					
	% P	% N	% S	N:S ratio	S:P ratio	N:P ratio
Total soluble solids (%)	0.22	0.85**	0.78**	0.52**	0.50**	0.68**
Ascorbic acid content (%)	0.11	0.70**	0.54**	0.57**	0.36**	0.58**

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