Journal Crop and Weed, 11(2):86-89(2015)

Efficacy of sulphur on growth, yield and quality of onion (*Allium cepa* L.)

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Received : 22.04.2015, Revised : 27.09.2015, Accepted : 15.10.2015

ABSTRACT

A field experiment was conducted on onion (Allium cepa L.) cv. Sukhsagar during the Rabi seasons of 2010-11 and 2011-12 at 'C' Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal to assess the influence of sulphur on growth, yield and quality in onion. The treatments comprised of four levels of sulphur (0, 15, 30 and 45 kg ha^{-1}) as basal application from two sulphur sources viz. gypsum and as elemental sulphur. The experiment was laid out in factorial randomized block design with three replications. Harvested onion was kept for four months in low cost storage structure and observations were recorded for physiological loss in weight and losses due to rotting and sprouting. Pooled results of two year revealed significantly highest total yield (298.81q ha^{-1}) and marketable yield (272.13 q ha^{-1}) with application of elemental sulphur @ 30 kg ha^{-1}. The highest amount of pyruvic acid content in bulb (4.5µmol g^{-1}) and minimal storage loss were also found from the same treatment. The study suggested that soil application of elemental sulphur @ 30 kg ha^{-1} is to be made for better yield, quality and shelf life of onion cultivar Sukhsagar under new alluvial zone of West Bengal.

***Keywords* :** Onion, pyruvic acid, quality, sulphur, storage

Onion (*Allium cepa* L.) is one of the most popular bulb vegetables and also commercially important vegetable worldwide. The productivity and quality of any crop depends on nutrients and environment under which it is cultivated. Although plants obtain certain amount of nutrients from the soil, they are inadequate to meet the demand for higher production. Therefore, it is most essential to provide major, secondary and micronutrient in balanced way towards sustainable production of a crop. Sulphur is one of the components that improve the yield and quality parameters of onion. Sulphur is a constituent of secondary compounds *viz*., allin, cycloallin and thiopropanol which not only influence the taste, pungency and medicinal properties of onion besides inducing resistance against pests and diseases. Sulphur is also required for the synthesis of three important essential amino acids such as cystine (27% S), cysteine (26% S) and methionine (21% S) besides increasing allyl propyl disulphide alkaloid (43% S) and the capsaicin, the principle alkaloids responsible for pungency in onion and chilli, respectively (Randle and Bussard, 1993). The continuous adaptation of sulphur free fertilizer in recent years coupled with decreased atmospheric input of sulphur has lead to a marked increase in the incidence of sulphur deficiency in the crops. With the above in view, the present investigation was undertaken to study the effect of sulphur application on growth, yield and quality along with post harvest shelf-life of onion bulbs under new alluvial zone of West Bengal.

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MATERIALS AND METHODS

A field experiment was conducted at the "C" Block Farm, Bidhan Chandra Krishi Viswavidyalaya, Kalyani, West Bengal for consecutive two years during the *Rabi* seasons of 2010-11 and 2011-12 to study the effect of different levels and sources of sulphur on growth, yield and quality of the bulb along with the post harvest shelf-life of onion cv. Sukhsagar. The experiment was comprised of four levels of sulphur (0, 15, 30 and 45 kg ha^{-1}) which were given as basal application from two sulphur sources *viz.* gypsum and as elemental sulphur. The experiment was laidout by adopting factorial randomized block design replicated thrice. The entire amount of sulphur was applied as basal along with recommended fertilizer dose (125:80:100::NPK kg ha^{-1}), where 1/3 of nitrogen was applied as basal and rest amount of nitrogen was applied in two equal splits- one after 30 days and second after 45 days of transplanting. Six weeks old onion seedlings were transplanted to main field at a spacing of 15 × 10 cm in each year during middle of November. The crop was harvested on 1st week of April. Other intercultural operations were made in time as scheduled for its cultivation. The produce obtained was further kept for four months storage in low cost storage structure. The growth parameters were recorded at 90 days after transplanting whereas the yield and quality parameters were recorded at time of harvest. After harvesting, bulbs were graded on the basis of size. The onion having equatorial diameter less than 35.00 mm recorded as "unmarketable grade", 35.00 to 45.00 mm as "C grade", 45.00 to 55.00 mm as "B grade" and 55.00 to 65.00 mm as "A grade". For the post harvest studies, treatment wise well cured 5 kg of samples along with leaves were collected and kept in bunch hanging method for observation. Observations were taken on storage behaviour (physiological loss in weight (PLW), sprouting and rotting on percent basis) upto four months with an interval of 30 days. The data taken annually were pooled and subjected to statistical analysis (Panse and Sukhatme, 1989).

RESULTS AND DISCUSSION

The results revealed that the treatments received sulphur fertilization rendered significant effects on growth and yield attributes of onion in comparison to untreated control. Regarding growth and yield parameters, the highest plant height (53.55 cm) along with maximum equatorial (5.81cm) and polar diameter (6.32 cm) of bulbs was found in treatment where plants received elemental sulphur at 30kg ha^{-1} while application of gypsum @15kg ha^{-1} showed its superiority in parameters like number of leaves (7.44) and percentage of A (29.21) and B (29.01) grade bulbs (Table 1). Highest percentage of C (58.02) grade bulbs was found in treatment where gypsum was applied @45kg ha^{-1} along with the minimum neck thickness (0.34 cm) of bulb. Maximum value for average weight (55.70 g) of bulbs was recorded from treatment receiving elemental sulphur at 30 kg ha^{-1}. The increase in plant height with the application of sulphur might be due to its role in the synthesis of chlorophyll. The present results are in conformity with the results of Jaggi (2005) and Channagoudra (2004) who also observed increased plant height of onion with increase in S levels. Significant increase in yield attributes like bulb polar diameter and equatorial diameter at higher levels of S application might be due to increase uptake of nutrients which might have influenced the synthesis and translocation of stored materials. These results are in accordance with the findings of Jaggi (2005), Nandi *et al.* (2002) and Hariyappa (2003).

Application of different doses of sulphur from different source rendered significant effect in parameters like total and marketable yield. Applications of elemental sulphur at 30 kg ha^{-1} recorded as best (298.81q ha^{-1} and 272.13 q ha^{-1} in total and marketable yield, respectively) while no sulphur treatment exhibited the least (265.83 q ha^{-1} and 241.59 q ha^{-1} in total and marketable yield, respectively) values regarding yield. The increase in bulb yield with application of higher levels of S might be due to increased uptake of N, P, K and S by the crop which might have enhanced the synthesis and translocation of photosynthates to the bulbs and the storage organs of the onion. Similar results were also reported in onion crop by Sankaran *et al*. (2005) and Jaggi (2005) who also recorded a significantly higher bulb yield of onion with the application of 30 kg S/ ha. Pradhan *et al*. (2015) also reported that application of S @30 or 45 kg ha^{-1} in the form of gypsum not only increases the bulb yield but also higher uptake of nutrients in onion.

Table 1 : Effect of sulphur on growth and yield attributing parameters of onion (Pooled)

Treatment	Plant height (cm)	No. of leaves	Equatorial diameter (cm)	Polar diameter (cm)	Neck thickness (cm)	Average bulb weight(g)	Grade of bulb (%) A	B	C	Marketable yield (q ha-1)	Total yield (q ha-1)
$S_1 L_1$	53.33	6.67	5.33	5.77	0.41	48.68	19.25	27.32	43.99	243.31	267.78
$S_1 L_2$	51.66	7.44	5.25	5.72	0.39	47.47	29.21	29.01	30.88	244.72	274.72
$S_1 L_3$	50.22	6.44	5.00	5.57	0.47	48.65	14.44	23.03	54.21	257.41	280.83
$S_1 L_4$	52.44	6.67	4.82	6.06	0.34	48.64	12.82	19.12	58.02	268.56	298.06
$S_2 L_1$	48.44	7.11	5.26	6.02	0.36	49.15	19.05	23.70	48.16	241.59	265.83
$S_2 L_2$	50.22	7.22	5.49	6.01	0.49	49.43	18.98	22.80	47.36	253.00	283.61
S_2L_3	53.55	6.22	5.81	6.32	0.42	55.70	18.33	21.68	51.18	272.13	298.81
S_2L_4	49.66	7.22	5.38	5.85	0.39	51.45	22.35	16.47	47.77	255.25	295.00
Mean	**51.19**	**6.88**	**5.29**	**5.91**	**0.40**	**49.90**	**19.30**	**22.89**	**47.70**	**254.50**	**283.08**
SEm(±) S	**1.49**	**0.16**	**0.88**	**1.04**	**0.27**	**0.74**	**1.95**	**1.82**	**3.06**	**7.00**	**6.88**
L	**2.11**	**0.23**	**1.25**	**1.47**	**0.39**	**1.05**	**2.76**	**2.58**	**4.33**	**9.90**	**9.74**
S×L	**2.99**	**0.33**	**1.77**	**2.07**	**0.54**	**1.48**	**3.91**	**3.65**	**6.13**	**14.01**	**13.77**
LSD S	**4.53**	**0.50**	**2.68**	**3.14**	**0.83**	**2.25**	**5.93**	**5.53**	**9.29**	**21.24**	**20.88**
(0.05) L	**6.41**	**0.70**	**3.79**	**4.45**	**1.17**	**3.18**	**8.38**	**7.82**	**13.14**	**30.04**	**29.53**
S×L	**9.07**	**1.00**	**5.36**	**6.29**	**1.65**	**4.50**	**11.85**	**11.06**	**18.58**	**42.48**	**41.76**
CV (%) 10.11	**8.27**	**5.78**	**6.07**	**23.06**	**5.15**	**35.06**	**27.59**	**22.25**	**9.53**	**8.42**	

Note: S_1: Gypsum S_2: Elemental sulphur; L_1: No sulphur, L_2: 15 kg S ha^{-1}, L_3: 30 kg S ha^{-1}, L_4: 45 kg S ha^{-1}

In parameters like total soluble solids (12.28 ºBrix) and pyruvic acid content (4.5µmol g^{-1}) in bulbs, application of elemental Sulphur @ 30kg ha^{-1} recorded the best values (Table 2). Such an increase in total soluble solids with increase in level of sulphur application was also reported by Kumar and Singh (1992). This might be due to increased synthesis of primary flavour compounds with S containing amino acids whose production increase with increase in S levels as reported by Randle and Bussard (1993). Similar results were also obtained by Channagoudra (2004). Increase in pyruvic acid content of bulb was due to increased uptake of S by crop due to its application to soil resulting in the increased synthesis of volatile sulphur compounds and production of more pungency in onion.

Table 2: Effect of sulphur on quality and storage parameters of onion (Pooled)

Treatment details		Bulb quality at harvest		Cumulative storage loss after 4 months			
		TSS (ºBrix)	**Pyruvic acid (µmol g-1)**	**PLW (%)**	**Sprouting (%)**	**Rotting (%)**	**Total loss (%)**
	S1 L1	10.69	3.36	16.15	3.00	6.07	25.22
	S1 L2	12.64	2.56	17.12	2.89	4.98	30.79
	S1 L3	11.69	2.29	17.78	1.98	4.25	24.01
	S1 L4	10.58	4.17	14.69	2.68	3.35	20.72
	S2 L1	10.90	2.02	15.84	2.90	5.16	23.9
	S2 L2	10.70	2.70	19.22	2.84	4.45	26.51
	S2L3	12.28	4.50	11.84	1.99	2.88	16.71
	S2 L4	10.52	2.28	22.63	1.85	6.31	24.99
	Mean	**11.25**	**2.47**	**16.91**	**2.52**	**4.68**	**24.11**
Sem(±)	**S**	**0.12**	**0.14**	**0.59**	**0.12**	**0.17**	**0.53**
	L	**0.17**	**0.20**	**0.83**	**0.17**	**0.24**	**0.76**
	S×L	**0.23**	**0.28**	**1.17**	**0.23**	**0.34**	**1.07**
LSD	**S**	**0.35**	**0.42**	**1.78**	**0.35**	**0.52**	**1.62**
(0.05%)	**L**	**0.50**	**0.60**	**2.52**	**0.50**	**0.73**	**2.29**
	S×L	**0.71**	**0.85**	**3.56**	**0.71**	**1.04**	**3.24**
CV (%)	**12.03**	**16.09**	**12.65**	**7.67**	**3.60**	**19.63**	

Hence, the inclusion of sulphur in the manurial schedule is very important to increase pungency in onion. Similar observations were made by Thippeswamy (1993), Randle and Bussard (1993) and Hariyappa (2003).

A significantly lower physiological weight loss (16.71%) of onion bulb was also recorded due to application of sulphur @ 30 kg ha^{-1}. Gawish (1998) and Ali (1998) observed improvement in storability of onion bulbs raised by feeding S fertilizers. Jaggi (2005) also observed reduced microbial infection due to sulphur fertilization in addition to imparting firmness to onion layers. This is in agreement with the findings of Nandi *et al.* (2002).

Comparing the results of different treatments, it can be opined that application of elemental sulphur @ 30 kg ha^{-1} should be made for quality crop with higher yield and better storability of onion in the new alluvial zone of West Bengal.

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