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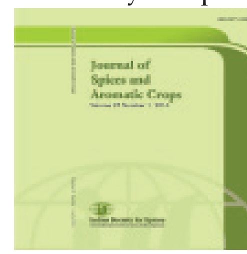

Efficacy of sulphur on growth, yield and bulb quality in onion (*Allium cepa* L.)

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Abstract

Sulphur has been recognised as an important nutrient for higher yield and quality of onion (*Allium cepa* L.) bulbs. Field experiment was conducted during *rabi*, 2010–11 to 2012–13 to study the efficacy of sulphur nutrition in onion. The treatment combination consisted of two sources of sulphur (gypsum and elemental sulphur) and four levels of sulphur (0, 15, 30 and 45 kg ha^{-1}) in Factorial RBD with three replications. The pooled results over three years revealed significantly higher efficacy of gypsum over elemental sulphur for polar diameter (3.13 cm), bulb weight (48.37 g) and marketable bulb yield (101.39 q ha^{-1}). Similarly, irrespective of sources, sulphur @ 30 kg ha^{-1} recorded significantly higher plant height (55.78 cm), number of leaves plant^{-1} (11.08), bulb weight (67.34 g), bulb yield (marketable, 160.71 q ha^{-1} and total, 224.52 q ha^{-1}) and TSS (12.03%) with higher BC ratio (1.47) as well as better shelf life. Application of sulphur @ 30 kg ha^{-1} as gypsum may be recommended in onion crop for obtaining higher bulb yield with higher BC ratio and better keeping quality.

Keywords: *Allium cepa,* bulb yield, onion, shelf life, sulphur nutrition

Introduction

Onion (*Allium cepa* L.) is one of the commercial vegetable and spice crops of India. India produces 159.30 lakh MT of onion from11.10 lakh ha (FAOSTAT 2011). India ranks first in area, second in production and third in export in the world. In India, onion is predominantly cultivated during rabi (60%) followed by 20% each in *kharif* and late *kharif* season. The higher productivity could be determined by selection of suitable varieties, balanced nutrition, optimum water management as well as need based plant protection measures. In recent times, the deficiency of sulphur is increasing in Indian soils as a result of indiscriminate use of fertilizers (www.sulphurindia.com 2014). Sulphur has been recognized as an important nutrient for higher yield and quality of onion bulbs (Lakkineni & Abrol 1994; Jaggi & Dixit 1999). Severe sulphur deficiency during bulb development has detrimental effect on yield and quality of onion (Ajay & Singh 1994). Sulphur containing secondary compounds is not only important for nutritive value or flavours but

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also for resistance against pest and diseases (Bell 1981). Onion storage is important to provide product for fresh market, export and processing. Keeping this in view, a field experiment was conducted to study about the effect of sources and levels of sulphur on growth, yield and bulb quality in onion.

Materials and methods

A field experiment was conducted during *rabi*, 2010–11 to 2012–13 at All India Network Research Project on Onion and Garlic (ICAR), College of Horticulture of Orissa University of Agriculture and Technology (OUAT), Odisha. Soil of the experimental area was sandy loam having pH of 5.89; available NPK 151:15:178 kg ha^{-1} with low sulphur content (9.75 ppm).The treatment combination consisted of two sources of sulphur (gypsum and elemental sulphur) and four levels of sulphur (0, 15, 30 and 45 kg ha^{-1}) in factorial RBD with three replications. The gypsum as source of sulphur as per the treatments was applied at the time of transplanting while the elemental sulphur was applied after 20-25 days of transplanting. The recommended dose of manures & fertilizers @150:50:80 kg NPK + 20 t FYM ha^{-1} was applied uniformly to all the treatments. The full dose of P, K and half dose of N were applied as basal dose while the remaining N was applied as top dressing at 30 days after transplanting. Seven weeks old seedlings were transplanted at a spacing of 15 cm row to row and 10 cm plant to plant. After harvest, 5 kg well cured bulbs, from each treatment were stored in low cost onion storage structure for storage study for a period of four months for % of physiological loss of weight (PLW), sprouting, rotting and total storage loss etc. The data recorded on various parameters were subjected to statistical analysis as per the procedure suggested by Sukhatme & Amble (1995).

Results and discussion

The data on vegetative, yield and yield attributing parameters as well as storage life as influenced by different sources and levels of sulphur in onion variety *Agrifound Dark Red* are presented in Tables 1 & 2.

Effect of sources of sulphur

The results obtained over three years of study showed that the vegetative parameters were not significant as influenced by the sources of sulphur (Table 1). However, Gypsum recorded higher number of leaves plant^{-1} (8.11) and neck thickness (0.52 cm) as compared to application of elemental sulphur (7.93 and 0.51 cm, respectively). But, application of elemental sulphur produced relatively higher plant height (38.88 cm) than gypsum, although both were statistically on par. No significant differences were observed due to different sources of sulphur for bulb yield and yield attributing parameters (Table 1). The pooled results over three years indicated that between two sources of sulphur, no significant differences were recorded except for polar diameter, average bulb weight, % of B grade and marketable bulb yield. Significantly higher polar diameter (3.13 cm), highest average bulb weight (48.37 g), % of B grade (18.66) and marketable bulb yield (101.39 q ha^{-1}) were recorded in application of gypsum as compared to elemental sulphur (2.96 cm, 43.19 g, 15.83% and 91.93 q ha^{-1}, respectively). Gypsum also recorded higher equitorial diameter (3.68 cm), % of A grade bulbs (10.78%) as well as total bulb yield (137.95 q ha^{-1}) which was statistically on par with elemental sulphur as source of sulphur (3.59 cm, 9.66% and 134.53 q ha^{-1}, respectively). In onion, production of less number of doubles and bolter bulbs are essential for producing higher marketable bulb yield. Similar results in onion were also reported by Dudhat *et al*. (2011) and Yaduvanshi & Yadav (2007).

Keeping quality and TSS of onion bulbs were not significantly influenced by different sources of sulphur over three years of study. However, application of gypsum indicated higher bulb TSS (8.50%) and better keeping quality parameters with reduction in rotting (16.00%), and sprouting (7.09%) as compared to elemental sulphur (16.45% and 7.32%, respectively) after four months of storage (Table 2).

The present study indicated that gypsum is a better source of sulphur for vegetative growth,

Table 1. Efficacy of sulphur on growth and bulb yield in onion var. *Agrifound Dark Red* (Pooled results from 2010–11 to 2012–13)

Treatment details	PH (cm)	NOL	ED (cm)	PD (cm)	NT (cm)	ABW (g)	AGB (%)	BGB (%)	CGB (%)	B (%)	D (%)	MY (q ha^{-1})	TY (q ha^{-1})	BC ratio
Sources (S)														
S1(Gypsum)	38.73	8.11	3.68	3.13	0.52	48.37	10.78	18.66	21.56	5.23	1.36	101.39	137.95	0. 78
S2 (Elemental Sulphur)	38.88	7.93	3.59	2.96	0.51	43.19	9.66	15.83	21.81	5.16	1.08	91.93	134.53	0.73
CD (P<0.05)	NS	NS	NS	0.18	NS	3.25	NS	2.89	NS	NS	NS	8.41	NS	—
Sulphur (kg ha^{-1}) levels (L)														
L1 (0)	47.77	10.03	4.55	3.88	0.67	53.38	8.69	20.91	30.83	6.65	0.93	89.17	125.94	0.40
L2 (15)	51.72	10.67	4.89	4.00	0.72	61.06	13.39	23.03	29.39	7.51	2.25	129.14	178.40	0.97
L3 (30)	55.78	11.08	4.97	4.30	0.68	67.34	17.14	24.87	26.85	6.97	1.27	160.71	224.52	1.47
L4 (45)	51.70	11.00	4.98	4.04	0.69	62.38	15.30	23.15	28.59	6.58	2.06	136.51	197.75	1.16
CD (P<0.05)	2.88	0.50	0.29	0.26	NS	4.59	2.26	NS	NS	NS	NS	11.90	10.93	—
S × L	4.07	NS	NS	NS	NS	6.50	3.20	NS	NS	NS	NS	NS	15.45	—

PH=Plant height; NOL=No. of leaves $plant^{-1}$; PD=Polar diameter; ED=Equitorial diameter; NT=Neck thickness; ABW=Average bulb weight; AGB=A grade bulbs; BGB=B grade bulbs; CGB=C grade bulbs; B=Bolter; D=Doubles; MY=Marketable bulb yield; TY=Total bulb yield; BC=Benefit cost

Table 2. Efficacy of sulphur on TSS and shelf life of onion variety *Agrifound Dark Red* (Pooled results from 2010–11 to 2012–13)

Treatments	PLW(%)	Sprouting(%)	Rotting(%)	Total loss (%) (PLW + Sprouting + Rotting)	TSS(%)
Sources (S)					
S1(Gypsum)	16.24	7.09	16.00	39.34	8.50
S2 (Elemental Sulphur)	16.16	7.32	16.45	39.94	8.49
CD (P<0.05)	NS	NS	NS	NS	NS
Sulphur (kg ha^{-1}) levels (L)					
L1 (0)	26.57	11.30	26.88	64.76	10.24
L2 (15)	21.99	10.03	20.94	52.96	11.21
L3 (30)	17.29	8.36	19.16	44.80	12.03
L4 (45)	20.56	8.76	19.56	48.88	11.83
CD (P<0.05)	4.21	NS	5.48	7.77	0.55
S × L	NS	NS	NS	NS	NS

PLW=Physiological loss of weight; TSS=Total soluble solids yield and yield attributing parameters as well as keeping quality of onion than elemental sulphur.

Effect of levels of sulphur

The results over three years on vegetative parameters as influenced by different levels of sulphur indicated significant variations among them. Application of sulphur @30 kg ha^{-1} recorded significantly higher plant height (55.78 cm) and number of leaves $plant^{-1}$ (7.08) than control and was statistically on par with application of sulphur @15 or 45 kg ha^{-1} for number of leaves $plant^{-1}$ (Table 1).

The results on yield and yield attributing parameters revealed significant variations among the levels of sulphur except for neck thickness, production of B & C grade bulbs, doubles and bolters (Table 1). Among the levels of sulphur, irrespective of sources, sulphur @30 kg ha^{-1} recorded significantly higher polar diameter (4.30 cm), equitorial diameter (4.97 cm), average bulb weight (67.34 g), A grade bulbs (17.145), marketable bulb yield (160.71 qha^{-1}) and total bulb yield (224.52 q ha^{-1}) than other levels. However, it was on par with application of sulphur @45 kg ha^{-1} for polar diameter and A grade bulbs. Hence, by considering bulb yield and other bulb yield attributing parameters application of sulphur @30 kg ha^{-1} showed better results in onion. These results confirm the earlier results of Kumar & Singh (1995) and Channagoudra *et al.* (2009) in onion.

Significantly highest TSS of 12.03% was recorded with application of sulphur @30 kg ha^{-1} than the control (10.24%). However, it was on par with sulphur @45 kg ha^{-1} (Table 2). Similar result was also reported by Channagoudra *et al.* (2009).

The pooled results indicated higher BC ratio of 1.47 for application of sulphur @30 kg ha^{-1} followed by 45 kg ha^{-1} (1.16).

Significant variations were observed among the treatments with respect to shelf life such as physiological loss of weight (PLW), rotting and total loss after four months of storage, irrespective of sources of sulphur. However, application of sulphur @30 kg ha^{-1} significantly reduced the PLW (17.29%), rotting (19.16%) as well as total loss (44.80%) after four months of storage as compared to control and 15 kg ha^{-1} and was on par with sulphur @45 kg ha^{-1}. All the interaction effects for various parameters under study were found non-significant, except average bulb weight, A grade bulbs and total bulb yield. Application of sulphur @30 kg ha^{-1} indicated better efficacy than other levels for keeping quality and TSS. Overall, the pooled results over three years of experimentation indicated that application of sulphur in the form of gypsum @30 kg S ha^{-1} was significantly superior for better growth, yield, and quality of bulbs in onion.

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