

Original Research Article

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## Effect of Sources and Graded Levels of Sulphur on Growth and Yield of Bellary Onion (*Allium cepa* L.)

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### ABSTRACT

#### Keywords

Sulphur, sources, levels, Onion, bulb yield

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A field experiment was conducted to study the effect of different sources and graded levels of sulphur on growth, yield attributes and yield of bellary onion at National Institute for Abiotic Stress Management, Malegaon Khurd, Baramati, Pune, Maharashtra. The treatments comprised of three sources of sulphur (Elemental sulphur- Bentonite clay, Potassium schoenite and ammonium sulphate) with graded levels of sulphur viz., 0, 30, 45 and 60 kg S ha<sup>-1</sup>. The experiment was laid out in randomized block design with four replications. The recommended doses of fertilizers were applied as per the crop production guide. Growth parameters viz., plant height, number of leaves and neck size were recorded at 30, 60, 90 and 120 DAT and yield attributing parameters viz., polar diameter, equatorial diameter and bulb yield were recorded at harvest. The results showed that growth attributes viz., plant height, number of leaves, neck size and yield parameters viz., polar diameter, equatorial diameter and average weight of bulb increased significantly up to 45 kg S ha<sup>-1</sup> and thereafter, declined in all sources of sulphur. The maximum bulb yield was obtained with the application of 45 kg S ha<sup>-1</sup> and it was significantly superior to 30 kg S ha<sup>-1</sup> and at par with 60 kg S ha<sup>-1</sup> in all sources of sulphur. Among the methods of application, 45 kg S ha<sup>-1</sup> as superior over nutripellet pack as soil application shows superiority over all other treatments.

### Introduction

Onion (*Allium cepa* L.) belong to the family of *Alliaceae*. Onion is one of the most important commercial vegetable and spice crop cultivated extensively in India. It is a short duration and quick growing crop and bulb is used as vegetable, spice and for medicinal value. The edible portion of onion is the bulb,

which is a modified organ consisting of thickened fleshy scale leaves and stem plate. It is used in several ways as fresh, frozen and dehydrated bulbs. As a nutritious vegetable, it contains carbohydrate (11.0 g), protein (1.2 g), calcium (180 mg), phosphorus (50 mg), iron (0.7 mg), nicotinic acid (0.4 mg), riboflavin (0.01mg) and vitamin C (11.0 mg) in each 100 g of edible portion (Bose *et al.*, 2000). Sulphur

requirement of onion is almost similar to that of phosphorus. Sulphur is a constituent of secondary compounds *viz.* allin, cycloallin and thiopropanol which are responsible for pungency and medicinal properties of onion and also inducing resistance against pests and diseases.

Sulphur deficiency in plant will affect the nitrogen metabolism in plants. Protein synthesis decreases when nitrogen is not fully utilized resulting in accumulation of non protein nitrogen in the plant. The critical N: S ratio varied with the crop and there is a strong relationship between total nitrogen, total sulphur and N-protein sulphur ratio. Sulphur deficiency causes 10 to 34 percent yield reduction in commercial crops. Sulphur deficiency is widespread in Indian soils and more than 40 % of the Indian soils are found to be deficient in sulphur (Tandon and Messick, 2007). Sulphur deficient plants had poor utilization of nitrogen, phosphorus and potash and showed a significant reduction in catalase activities at all stage of crop growth. Sulphur deficiency during bulb development had detrimental effect on yield and quality of onion.

Sulphur fertilization is required for alleviating sulphur deficiency and for increased crop productivity in crops like onion. In recent years, sulphur is applied as soil amendment and also as a factor of increasing fertilizer use efficiency. Application of sulphur has several beneficial effects such as reducing pH, improving soil water retention and increasing availability of nutrients. Gondane *et al.*, (2018) reported that a total soluble solids of onion bulb was significantly influenced due to application of different levels of sulphur. In the past, sulphur need of soil and crop was satisfied by use of seemingly incidental means like use of sulphur bearing superphosphate, ammonium sulphate, potassium sulphate, sulphur based pesticides, atmospheric SO<sub>2</sub> and manures *etc.* But in recent years, the trend to

use high analysis fertilizers and pesticides which are sulphur free, has resulted in sulphur deficient soils. It is necessary to estimate onion response to sulphur fertilization on sulphur deficient soils of Maharashtra. It is also necessary to identify the cheaper and easily available source of sulphur fertilizer. It was strongly felt that enriching the soil with sulphur fertilizer would be beneficial for onion crop of Western Maharashtra region. An investigation was, therefore, conducted to study the effect of sources and levels of sulphur on growth, productivity of onion.

### **Materials and Methods**

A field experiment was conducted during *Rabi*, 2018 and 2019 at National Institute for Abiotic Stress Management (ICAR-NIASM), Malegaon Khurd, Baramati, Pune, Maharashtra. The experimental soil was alkaline (pH 8.2), clay loam in texture, low in organic carbon (3.2 g kg<sup>-1</sup>), low in KMnO<sub>4</sub> (110 kg ha<sup>-1</sup>), high in Olsen P (15 kg ha<sup>-1</sup>) and medium in NH<sub>4</sub>OAC K (200 kg ha<sup>-1</sup>). The soil had Ca content of 611 ppm, Mg content of 53 ppm and S content of 6.3 ppm. The experiment was laid out in randomized block design with three replications. There were fourteen treatments comprising of four doses of sulphur *viz.*, 0, 30, 45 and 60 kg ha<sup>-1</sup> and three sulphur sources (Elemental sulphur-Bentonite clay, Potassium schoenite and ammonium sulphate). Plot size was 3 x 4 m and plant spacing was 15 x 10 cm. Recommended dose of N: P<sub>2</sub>O<sub>5</sub>: K<sub>2</sub>O (110:40:60 kg ha<sup>-1</sup>) was applied to all the plots except control. The sources of nitrogen, phosphorus and potassium were urea, dia ammonium phosphate and muriate of potash respectively. The sources of sulphur were elemental sulphur (80% sulphur as Bentonite Clay), potassium schoenite (21.5% sulphur) and ammonium sulphate (24% sulphur). 100 % RD of phosphorus and potassium and 50 % RD of nitrogen were applied before transplanting. The remaining 50% RD of

nitrogen was applied in two equal splits at 30 and 45 days after transplanting. Onion variety Bhima Kiran was selected for the study. Regular package of package of practices were followed as per crop production guide. The observations were recorded from five randomly selected competitive plants in each treatment and replication. Growth parameters viz., plant height, number of leaves, neck size, polar and equatorial diameter of bulb and average bulb weight were recorded. Bulb yield per hectare was computed from the yield obtained per plot. The results on growth, yield attributing parameters and yield were tabulated and subjected to statistical analysis. The total variation of different treatments was tested for significance by “F” test using analysis of variance technique.

## Results and Discussion

### Growth parameters

There was a considerable increase in plant height of onion in all the treatments from 30 to 120 days of crop growth. Maximum plant height of 72 cm was registered in the treatment T<sub>9</sub> receiving 45 kg S ha<sup>-1</sup> as potassium schoenite through nutripellet pack which was also significantly superior over rest of the treatments. Plant height was minimum (33 cm) in control treatment without any NPK and sulphur fertilization (Table1). Sulphur application along with recommended dose of NPK fertilizers and organic manure exerted positive effect on plant height which might be due to the role of nitrogen in chlorophyll structure which is responsible for photosynthesis and manufacture of food material in the plants. Irrespective of the treatments, the numbers of leaves of onion were increased from 30 to 120 days after transplanting. Maximum number of leaves of 8.1, 9.7, 11.7 and 11.7 were noticed in the treatment T<sub>9</sub> on 30, 60, 90 and 120 DAT, respectively. This treatment was significantly superior over rest of the treatments, on all the

days of observations, which revealed superiority of potassium schoenite applied @ 45 kg S ha<sup>-1</sup> through nutripellet pack to other sources of sulphur and other methods of application. Nayak *et al.*, (2016) reported that the yield attributes like plant height, bulb length, bulb diameter, neck length and average weight of bulb were increased significantly up to 35 kg sulphur ha<sup>-1</sup> and thereafter, declined with higher dose of sulphur application (50 kg S ha<sup>-1</sup>) in both the sources.

### Yield attributing parameters

Application of sulphur through different sources to onion crop significantly increased polar diameter of onion over control treatment. Maximum polar diameter of 5.98 cm was noticed in the treatments T<sub>9</sub> receiving 45 kg S ha<sup>-1</sup> as potassium schoenite through nutripellet pack which was significantly superior over all other treatments (Table 2). Tripathy *et al.*, (2013) reported that maximum equatorial (5.17 cm) and polar (5.17 cm) diameter of bulb recorded with the application of 30 kg S ha<sup>-1</sup>. Maximum equatorial diameter of 8.55 cm was noticed in the treatment T<sub>9</sub> receiving 45 kg S ha<sup>-1</sup> as potassium schoenite through nutripellet pack which is significantly superior over a treatment T<sub>5</sub> receiving 45 kg S ha<sup>-1</sup> as elemental sulphur with *Thiobacillus* and nutripellet pack application (7.43 cm), which showed the significance of potassium schoenite over elemental source of sulphur in respect of equatorial diameter (Table2). Chattopadhyay *et al.*, (2015) reported that maximum equatorial (5.81cm) and polar diameter (6.32 cm) of bulbs were found in treatment where plants received elemental sulphur at 30 kg ha<sup>-1</sup>. Thus both polar and equatorial diameter play important role in determining the shape and size of onion bulbs.

More efficient sulphur utilization resulted in greater increase in bulb diameter. Neck size of onion plant was significantly improved due to application of 45 kg S ha<sup>-1</sup> as potassium

schoenite through nutripellet pack (T<sub>9</sub>) and 45 kg S ha<sup>-1</sup> as elemental sulphur + Thiobacillus through nutripellet pack (T<sub>5</sub>) over all other treatments.

Maximum neck size (2.29 cm) was noticed in the treatment T<sub>9</sub> followed by the treatment T<sub>5</sub>. Ulkey *et al.*, (2015) reported that application of 30 kg S ha<sup>-1</sup> resulted neck thickness 1.34 cm of onion.

### **Yield**

Maximum bulb yield of 46.55 kg plot<sup>-1</sup> was recorded in the treatment T<sub>9</sub> followed by a treatment T<sub>5</sub> (40.14 kg plot<sup>-1</sup>). There was significance elevation in the bulb yield of onion owing to sulphur application through different sources over a control treatment. Qureshi and Lawande (2006) reported that onion yield increased with increasing sulphur nutrition levels up to 75 kg S ha<sup>-1</sup> yield in low sulphur soils (<10 ppm S).

Meher *et al.*, (2016) reported that graded levels of sulphur application linearly increased the yield up to 50 kg ha<sup>-1</sup> with bulb yield of 35.5 tonnes. The marketable bulb yield obtained in the treatment T<sub>9</sub> and T<sub>5</sub> were significantly higher over rest of the treatments (Table2). Gondane *et al.*,(2018) revealed that the sulphur application @ 40 kg ha<sup>-1</sup> was found to be better in yield contributing characters like weight of fresh as well as cured bulb, diameter of bulb, number of marketable bulbs, weight of marketable bulb per plot, total yield per plot and total yield per hectare.

Potassium schoenite and elemental sulphur applied @ 45kg S ha<sup>-1</sup> through nutripellet pack have assisted in elevating the marketable yield as compared to a dose of 60 kg S ha<sup>-1</sup>. Mishu *et al.*, (2013) reported that application of 40 kg S ha<sup>-1</sup> resulted in the highest yield (10.65 t ha<sup>-1</sup>) among the different doses of

sulphur. There was positive effect of sulphur application on both bulb yields per plot and per hectare. Increasing dose of sulphur from 30 to 45 kg ha<sup>-1</sup> also caused significant increase in the yield of onion.

Maximum yield production was noticed the treatment receiving 45 kg sulphur ha<sup>-1</sup> through potassium schoenite followed by elemental sulphur, therefore, depicting superiority of potassium schoenite over other two sources of sulphur.

Application of 45 and 60 kg S ha<sup>-1</sup> through potassium schoenite, elemental sulphur and ammonium sulphate significantly increased the bulb yield over the treatment receiving 30 kg S through elemental sulphur alone (T<sub>2</sub>). Sulphur dose of 45 kg S ha<sup>-1</sup> is sufficient for Bhima Kiran variety of onion grown in medium black soils of Baramati area.

The results can be summarized that application of 45 kg sulphur ha<sup>-1</sup> is sufficient for Bhima Kiran variety of bellary onion grown in medium black soils of Baramati area.

Application of potassium schoenite applied @ 45 kg S ha<sup>-1</sup> through nutripellet pack to other sources of sulphur and its other method of application shows better results in number of leaves in onion. Neck size of onion plant was significantly improved due to application of 45kg sulphur ha<sup>-1</sup> as potassium schoenite through nutripellet pack and 45kg sulphur ha as elemental sulphur + *thiobacillus* through nutripellet pack over all other treatments.

Soil application of nutrients is inferior to nutripellet pack application as far as neck size is concerned. Application of sulphur @ 45 and 60 kg sulphur ha<sup>-1</sup> resulted in significantly increase in equatorial diameter of onion, over a treatment 30kg sulphur ha<sup>-1</sup> by surface application.

**Table.1** Effect of sources and graded levels of sulphur on growth attributes attributes of bellary onion

Treatments	Plant height (cm)				No. of leaves				Neck size (cm)
	30 DAT	60 DAT	90 DAT	120 DAT	30 DAT	60 DAT	90 DAT	120 DAT	At harvest
<b>T<sub>1</sub> Absolute Control</b>	23	24	26	33	5.1	6.1	7.0	7.0	1.13
<b>T<sub>2</sub> RDF + S @30 kg ha<sup>-1</sup> soil application</b>	37	42	52	54	6.5	7.1	7.6	7.6	1.26
<b>T<sub>3</sub> RDF+ S@45 kg ha<sup>-1</sup> as elemental S+ Thiobacillus -Soil application</b>	35	41	54	56	6.6	8.1	9.3	9.4	1.43
<b>T<sub>4</sub> RDF + S@60 kg ha<sup>-1</sup> as elemental S+ Thiobacillus - Soil application</b>	40	42	43	46	7.1	7.1	7.3	7.3	1.06
<b>T<sub>5</sub> RDF +S@45 kg ha<sup>-1</sup> as elemental S +Thiobacillus –Nutripellet Pack</b>	41	46	58	59	6.2	7.2	9.6	9.6	1.86
<b>T<sub>6</sub> RDF +S@60 kg ha<sup>-1</sup> as elemental S+ Thiobacillus –Nutripellet Pack</b>	30	38	49	51	5.7	6.1	8.0	8.0	1.66
<b>T<sub>7</sub> RDF +S@45 kg ha<sup>-1</sup> as Potassium Schoenite-Soil application</b>	43	45	48	51	6.0	6.6	7.3	7.5	1.36
<b>T<sub>8</sub> RDF +S@60 kg ha<sup>-1</sup> as Potassium Schoenite-Soil application</b>	32	41	49	51	5.9	6.4	7.3	7.4	1.56
<b>T<sub>9</sub> RDF +S@45 kg ha<sup>-1</sup> as Potassium Schoenite - Nutripellet Pack</b>	50	59	72	72	8.10	9.7	11.7	11.7	2.29
<b>T<sub>10</sub> RDF +S@60 kg ha<sup>-1</sup> as Potassium Schoenite - Nutripellet Pack</b>	32	41	49	50	6.1	7.6	8.6	8.6	1.66
<b>T<sub>11</sub> RDF +S@45 kg ha<sup>-1</sup> as Ammonium Sulphate -Soil application</b>	39	50	52	52	6.9	7.1	8.6	8.7	1.53
<b>T<sub>12</sub> RDF +S@60 kg ha<sup>-1</sup> as Ammonium Sulphate -Soil application</b>	39	47	56	56	6.4	7.5	8.7	8.8	1.33
<b>T<sub>13</sub> RDF +S@ 45 kg ha<sup>-1</sup> as Ammonium Sulphate - Nutripellet Pack</b>	30	45	56	56	5.7	7.2	9.0	9.0	1.53
<b>T<sub>14</sub> RDF +S@60 kg ha<sup>-1</sup> as Ammonium Sulphate - Nutripellet Pack</b>	32	45	55	56	5.7	6.9	7.6	7.7	1.56
<b>SED</b>	2.1	0.16	5.0	0.40	0.22	0.04	0.84	0.03	0.17
<b>CD (p = 0.05)</b>	4.3	0.38	10.3	0.96	0.46	0.09	1.73	0.08	0.36

RDF: Recommended dose of NPK fertilizers

**Table.2** Effect of sources and graded levels of sulphur on Yield attributes and yield component of bellary onion

Treatments	Polar diameter (cm)	Equatorial diameter (cm)	Bulb yield kg plot <sup>-1</sup>	Yield t ha <sup>-1</sup>	Marketable yield t ha <sup>-1</sup>
T <sub>1</sub> Absolute Control	3.25	4.46	23.67	29.5	26.85
T <sub>2</sub> RDF + S @ 30 kg ha <sup>-1</sup> soil application	4.26	5.43	29.75	37.2	34.86
T <sub>3</sub> RDF+ S @ 45 kg ha <sup>-1</sup> as elemental S+ Thiobacillus -Soil application	4.23	5.70	34.83	43.5	41.51
T <sub>4</sub> RDF + S @ 60 kg ha <sup>-1</sup> as elemental S+ Thiobacillus - Soil application	4.6	6.66	34.22	42.8	41.63
T <sub>5</sub> RDF +S @ 45 kg ha <sup>-1</sup> as elemental S + Thiobacillus –Nutripellet Pack	5.35	7.43	40.14	48.7	46.88
T <sub>6</sub> RDF +S @ 60 kg ha <sup>-1</sup> as elemental S + Thiobacillus –Nutripellet Pack	5.01	6.56	32.96	41.2	38.94
T <sub>7</sub> RDF +S @ 45 kg ha <sup>-1</sup> as Potassium Schoenite-Soil application	4.87	6.43	34.65	42.9	39.55
T <sub>8</sub> RDF +S @ 60 kg ha <sup>-1</sup> as Potassium Schoenite-Soil application	4.67	6.36	34.41	43.0	41.99
T <sub>9</sub> RDF +S @ 45 kg ha <sup>-1</sup> as Potassium Schoenite - Nutripellet Pack	5.98	8.53	46.55	53.9	52.87
T <sub>10</sub> RDF +S @ 60 kg ha <sup>-1</sup> as Potassium Schoenite - Nutripellet Pack	5.02	7.00	33.35	41.5	39.59
T <sub>11</sub> RDF +S @ 45 kg ha <sup>-1</sup> as Ammonium Sulphate -Soil application	5.00	6.63	35.02	44.8	42.05
T <sub>12</sub> RDF +S @ 60 kg ha <sup>-1</sup> as Ammonium Sulphate -Soil application	5.04	7.06	35.0	44.6	41.77
T <sub>13</sub> RDF +S @ 45 kg ha <sup>-1</sup> as Ammonium Sulphate - Nutripellet Pack	5.15	7.01	33.18	41.5	40.82
T <sub>14</sub> RDF +S @ 60 kg ha <sup>-1</sup> as Ammonium Sulphate - Nutripellet Pack	4.82	7.00	35.32	44.4	42.42
SED	0.16	0.13	1.05	0.98	1.17
CD (P = 0.05)	0.33	0.27	2.13	1.72	2.24

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