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Effect of different sulphur fertilization regimes on yield and quality of Onion (*Allium cepa* L.)

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Abstract
A field experiment was carried out at Regional Research and Technology Transfer Station, OUAT, Chiplima, Odisha during *Rabi* 2018 to study the effect of different sources of sulphur on growth and yield of Onion. The experiment comprised of 12 treatment combinations with different sources of sulphur like gypsum, gromor sulphur and gromor and replicated thrice. The treatment combinations were T_1: Absolute control, T_2:100% recommended dose of fertilizer (RDF), T_3: 100% RDF + Zn (5 kg/ha) + B (1 kg/ha), T_4: T_3+ S(20 kg/ha) Gypsum, T_5: T_3+ S(40 kg/ha) Gypsum, T_6: T_3+S(60 kg/ha) Gypsum, T_7: T_3+ S(20 kg/ha) Gromor sulphur, T_8: T_3+ S(40 kg/ha) Gromor sulphur, T_9: T_3+ S(60 kg/ha) Gromor sulphur, T_{10}: T_3+ S(20 kg/ha) Gromor, T_{11}: T_3+ S(40 kg/ha) Gromor and $T12$: T_3+ S(60 kg/ha) Gromor. Significantly highest bulb yield and sulphur uptake was obtained when Gromor sulphur was applied @ 40 kg/ha along with 100% recommended dose of fertilizer, Zinc (5 kg/ha) and Boron (1 kg/ha). Higher value of TSS (Total Soluble Solids) was also obtained under T_8. Hence.

Keywords: Gromor, gromor sulphur, gypsum, TSS

Introduction
Onion (*Allium cepa* L.) belonging to family Alliaceae, is the second most important commercial crops in India next to Potato. It is one of the commercial vegetable cum spice crop which is an indispensable item in every kitchen and hence called the "Queen of Kitchen". India ranks second in terms of production in World. Worldwide onion productivity is 18.8 t ha^{-1} which is higher than the productivity of onion in India (17.2 t ha^{-1}) (FAOSTAT, 2017). In Odisha, the productivity of Onion is 11.3 t ha^{-1} (Horticulture Statistics at a glance, 2017), which is 1.5 times lower than the productivity of India. The low productivity may be attributed to improper use of macro- and micro nutrients in Onion.

In recent years, sulphur is receiving more attention throughout the world. Sulphur is essential for building up sulphur containing amino acids in plant cells. It helps in vegetative growth and bulb development in onion (Anwar *et al*., 2001) [1]. Sulphur is responsible for the bulb pungency since it is a. primary component in allyl propyl disulphide and also helps in production of bioactive compounds (McCallum *et al*., 2005) [6]. Lancaster *et al*. (2001) [3] showed that low sulphur supply reduced the sulphur in cell walls and also decreased the bulb hardness and the storage life of onion bulbs. Onion is referred to as sulphur loving crop and yield increases with increase in sulphur dose (Tripathy *et al*., 2013; Magray *et al*., 2017) [12, 5]. Hence, an attempt was made to evaluate the effect of different sources of sulphur on the growth and yield of Onion.

Materials and Methods
The current investigation was carried out in the Research farm of Regional Research and Technology Transfer Station, Chiplima, Sambalpur, Odisha during *Rabi* 2018. The pH of the experimental soil is 6.85 with low N (187 kg/ha), medium P (15.4 kg/ha) and K (172 kg/ha). The soil is also low in S, Zn and B with values of 7.46, 1.23 and 0.27 ppm, respectively. The experiment was replicated thrice and laid out in RBD. There were 12 treatments as given in Table 1. Recommended dose of fertilizer was 120:60:100 (N: P_2O_5: K_2O). Sulphur was applied in the form of Gypsum (18% S), Gromor sulphur (90% elemental S), Gromor (13% S). Boron and zinc were applied in the form of Borax (14.6% B) and zinc sulfate (22% Zn, 11% S). Onion variety Gawran Special (LR-241) was taken in the experiment having crop duration of 160-170 days.

The nursery bed was prepared with 1m width and incorporated with 20 kg FYM. The seeds were sown in nursery and 55 days old seedlings were transplanted in the last week of

December. The main field was ploughed thoroughly and the layout was done followed by Chloropyriphos 1.5% DP dusting @ 25kg/ha. The onion seedlings were transplanted at a spacing of 20cm x 10 cm and lifesaving irrigations was given to save the crop. Plant protection measures and cultural practices were done to keep the field weed and disease free.

Plant height was measured from the ground level to the tip of the highest leaf using a standard ruler. The number of fully developed active green leaves was counted. Days to maturity was determined by taking the number of days from seedling transplanting to a day at which more than 70% of the plants in a plot showed yellowing of leaves or attained physiological maturity.

After harvesting, bulbs were weighed separately to obtain fresh mass per bulb of 10 randomly selected bulbs harvested from the net plot. The fresh mass of all bulbs harvested from net plot size was converted to t ha^{-1} in order to indicate onion yield. The same 10 bulbs were then used to measure the quality parameter. The diameter of bulbs was measured at right angles to the longitudinal axis at the widest circumference of the bulb using a digital calliper. Similarly the neck diameter was also measured and expressed in cm. The bulb length was measured along the entire length of onion from base to the top of bulb and expressed in cm.

To determine the sulphur content in onion plants, the chopped plant samples were dried at 65 °C till constant weight was attained. Then it was digested using diacid mixture of perchloric acid and nitric acid and was estimated using turbidi metric method (Chesnin and Yien, 1950) [2]. The Total Soluble Solids (TSS) of onion bulbs was determined by hand refractometer and percent TSS was noted down. Analytical values obtained were subjected to statistical analysis using STAR software.

Table 1: Treatments details

Abbreviation	Treatment Details
T1	Absolute control
T2	100% RDF
T3	100% RDF + Zn (5kg/ha) + B (1kg/ha)
T4	T_3+ S(20kg/ha) Gypsum
T5	T_3+ S(40kg/ha) Gypsum
T6	T_3+S(60kg/ha) Gypsum
T7	T_3+ S(20kg/ha) Gromor sulphur
T8	T_3+ S(40kg/ha) Gromor sulphur
T9	T_3+ S(60kg/ha) Gromor sulphur
T10	T_3+ S(20kg/ha) Gromor
T11	T_3+ S(40kg/ha) Gromor
T12	T_3+ S(60kg/ha) Gromor

*RDF- Recommended dose of fertilizer

Results and Discussion

Growth parameters

The plant height was significantly affected with the application of different sulphur regimes and the highest plant highest was observed with the treatment T8 i.e. 100% RDF + Zn (5 kg/ha)+B (1 kg/ha)+S (40 kg/ha) Gromor sulphur (Table 2). It was significantly at par with the other treatments and significantly higher over absolute control. Similar result was obtained by Nasreen *et al*. 2007 [7] who reported that plant height increased significantly upto sulphur application of 40kg/ha but reduced at 60kg/ha. There was no significant effect of different sulphur regimes on the number of leaves per plant.

Yield parameters: There was significant effect of different fertilization regimes on the bulb length, average weight of bulb and dry weight of bulb (Table 2). Among the different sources of sulphur i.e. gypsum, gromor sulphur and gromor, the gromor sulphur resulted in higher yield attributing characters. It might be because of the sulphate ions present in gromor sulphur which is in micro ionised form that is released slowly for proper utilization by the crop. But in case of gypsum, the sulphate ions are less and sulphide ions are present which gets leached away upon irrigation. Similar results were obtained by Tripathy *et al*., 2013; Nayak *et al*., 2016 [12, 9]. Bulb diameter and neck diameter were not significantly affected by fertilization regimes.

Table 2: Effect of different sources and doses of sulphur on yield attributing characters of onion

	Plant height (cm)	No. of leaves	Bulb length (cm)	Bulb diameter (cm)	Neck diameter (cm)	Average weight of bulb (g)	Dry weight of bulb (g)
Absolute control	28.2	5.6	6.5	3.8	1.3	98.6	35.4
100% RDF	36.4	7.3	7.7	4.6	1.4	130.9	35.4
100% RDF + Zn (5kg/ha) + B (1kg/ha)	37.8	7.6	7.7	4.3	1.4	146.3	47.0
T_3+ S(20kg/ha) Gypsum	39.7	7.9	7.8	4.6	1.5	150.7	52.5
T_3+ S(40kg/ha) Gypsum	40.7	8.1	7.9	4.4	1.4	168.3	54.1
T_3+ S(60kg/ha) Gypsum	40.4	8.1	7.7	4.5	1.5	162.6	60.4
T_3+ S(20kg/ha) Gromor sulphur	40.4	8.1	7.2	4.5	1.5	172.3	58.4
T_3+ S(40kg/ha) Gromor sulphur	41.4	8.3	8.5	4.7	1.5	195.8	61.8
T_3+ S(60kg/ha) Gromor sulphur	40.0	8.0	7.5	4.2	1.6	183.9	70.3
T_3+ S(20kg/ha) Gromor	40.0	8.0	7.3	4.5	1.4	150.7	66.0
T_3+ S(40kg/ha) Gromor	40.2	8.0	7.4	4.3	1.5	157.7	54.1
T_3+ S(60kg/ha) Gromor	39.6	7.9	7.6	4.2	1.4	140.1	56.6
CD	7.0	NS	0.9	NS	NS	38.9	13.9

Bulb Yield

It has been observed that there is a significant quantum jump in bulb yield with application of 40 kg S by Gromor sulphur along with 100% recommended dose of fertilizer and Zinc (5 kg/ha) and Boron (1 kg/ha) indicating favorable response of sulphur fertilizer (Table 3). Similar results were obtained by Qureshi and Lawande (2006) [10] who revealed that onion yield increased with increasing sulphur nutrition level up to 75 kg/ha in low sulphur soils. Nasreen *et al*., 2003 [8] also reported lower yield with no application of sulphur.

Table 3: Effect of different sources and doses of sulphur on yield and sulphur uptake of onion

	Bulb yield (t ha^{-1})	Dry matter accumulation	Sulphur content (%)	Sulphur uptake (kg/ha)	TSS (%)
Absolute control	14.02	9.35	0.24	22.11	10.18
100% RDF	17.21	11.47	0.31	36.59	10.23
100% RDF + Zn (5kg/ha) + B (1kg/ha)	18.29	12.19	0.33	39.87	10.29
T_3+ S(20kg/ha) Gypsum	19.14	12.76	0.34	43.80	10.90
T_3+ S(40kg/ha) Gypsum	21.23	14.15	0.35	49.73	11.01
T_3+S(60kg/ha) Gypsum	20.80	13.87	0.35	48.45	10.92
T_3+ S(20kg/ha) Gromor sulphur	20.01	13.34	0.35	48.28	10.99
T_3+ S(40kg/ha) Gromor sulphur	23.60	15.73	0.36	56.16	11.42
T_3+ S(60kg/ha) Gromor sulphur	21.22	14.15	0.34	48.84	11.28
T_3+ S(20kg/ha) Gromor	20.10	13.40	0.34	46.17	11.03
T_3+ S(40kg/ha) Gromor	20.57	13.71	0.35	47.51	11.32
T_3+ S(60kg/ha) Gromor	19.78	13.19	0.34	45.03	11.18
CD	3.80	2.54	NS	12.03	NS

Sulphur Uptake

Sulphur uptake by onion plant increased significantly with increasing the sulphur levels up to 40 kg/ha (Table 3). Among the different levels of sulphur, application of gromor sulphur registered the maximum uptake at 40 kg/ha (56.16 kg/ha). Increase in sulphur uptake decreased with increasing sulphur administration at 60kg/ha irrespective of the sources of sulphur i.e. gypsum, gromor and gromor sulphur. Lee *et al*. (2009) [4] observed that the increase in sulphur content in bulbs was restricted to addition of sulphur up to 13 kg/ha. The decrease in response to additional sulphur supply could be due to the supply of sulphur partly through the native soil sulphur and irrigation water.

Quality Parameter

TSS was not significantly influenced by different fertilization regimes. Similar result was obtained by Thangasamy *et al*., 2013 [11]. However numerically higher value of TSS was observed in treatment T8 (11.42%).

Conclusion

It was concluded that the growth parameters, bulb yield and sulphur uptake was found highest when 40kg/ha S was applied in the form of Gromor sulphur along with 100% recommended dose of fertilizer, Zinc (5kg/ha) and Boron (1kg/ha). With increase in dose of sulphur, the yield declined. Hence, optimum yield was obtained with application of gromor sulphur @ 40 kg/ha.

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