**Effect of Different Sources and Levels of Sulphur on Growth and Yield of Maize (Zea mays L.)**

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**Abstract**

A field experiment was conducted during Kharif, 2017 at College Farm, College of Agriculture, Rajendranagar, Hyderabad to compute the optimum dose and source of sulphur in maize and to evaluate the impact of sulphur on growth, yield attributes and yield of maize. The experiment was carried out with three different sources of sulphur (Gypsum, Ammonium Sulphate and Bentonite Sulphur) and three levels (S @ 40 kg ha⁻¹, S @ 60 kg ha⁻¹ and S @ 80 kg ha⁻¹) and one source as urea, DAP and MOP and another source as urea, SSP and MOP comprising of eleven treatment combinations which were laid out in randomized block design and replicated thrice. In all the treatments nitrogen was applied in two split doses 50% as basal and 50% as top dressing at 45 DAS and entire dose of phosphorous, potassium and sulphur were applied as basal. Treatment T₁ was application of recommended dose of fertilizer i.e., N-P₂O₅-K₂O-S @ 200-60-50-60 kg ha⁻¹ without sulphur. Treatment T₂ was application of recommended dose of fertilizer through Urea, SSP and MOP. T₃ was T₁+ application of sulphur @ 40 kg ha⁻¹ through gypsum; T₄ was T₁+ application of sulphur @ 60 kg ha⁻¹ through gypsum; T₅ was T₁ + application of sulphur @ 80 kg ha⁻¹ through gypsum. T₆ was T₁ + application of sulphur @ 40 kg ha⁻¹ through ammonium sulphate. T₇ was T₁ + application of sulphur @ 60 kg ha⁻¹ through ammonium sulphate. T₈ was T₁ + application of sulphur @ 80 kg ha⁻¹ through ammonium sulphate. T₉ was T₁+ application of sulphur @ 40 kg ha⁻¹ through bentonite sulphur. T₁₀ was T₁ + application of sulphur @ 60 kg ha⁻¹ through bentonite sulphur. T₁₀ was T₁ + application of sulphur @ 80 kg ha⁻¹ through bentonite sulphur. Highest grain (5596 kg ha⁻¹) and stover yield (6995 kg ha⁻¹) was recorded by treatment T₁₀ (S@60 kg ha⁻¹ through bentonite sulphur) followed by treatment T₂ (5516 and 6976 kg ha⁻¹) S@40 kg ha⁻¹ through urea, SSP and DAP. Highest gross returns were recorded by T₁₀ (Rs. 80139 ha⁻¹) followed by T₂ (Rs. 78623 ha⁻¹) though highest B: C ratio was recorded by T₂ because of higher cost of bentonite sulphur fertilizer.

**Keywords**

Maize, Zea mays L., Sulphur

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**Introduction**

Maize is one of the important cereal crops in the world's agricultural economy both as food for humans and feed for animals, because of its higher yield potential compared to other cereals it is called as “Queen of Cereals”. Maize is a miracle crop as there is no cereal crop on earth which has so immense potentiality and nutrient extensive feature.
India is ranks 6th in World’s maize production. In India, maize is cultivated in an area of 8.85 lakh ha with a total production of 22.84 lakh tons and productivity of 2580kg ha\(^{-1}\) (Department of Economics and Statistics, 2017). Maize has been considered as highly nutrient responsive crop with wide adaptability and compatibility under diverse soil and climatic conditions. It has a variety of uses and has become popular due to its nutritive value and wide spread acceptability by humans. In India, maize (Zea mays L.) is the third most important cereal after rice and wheat that provides food, feed, fodder and serves as a source of raw material for developing hundreds of industrial products viz., starch, protein, oil, alcoholic beverages, food sweeteners, pharma, cosmetics, bio-fuel etc. Maize contains 4.5% oil which is ideal cooking medium for various recipes. About 66% of total maize production is used as feed, 25% as food and industrial products while the rest is used as seed etc. (Binod kumar et al., 2016). Due to higher yield potential, short growing period, high value food, forage and feed for livestock, poultry and a cheaper source of raw material for agro based industry, it is increasingly gaining importance in cropping systems. Among many reasons for low productivity, mismanagement of plant nutrition and agronomic practices are considered to be the major ones. Hence, for getting higher maize production of better quality, there is a need to improve these two major components of production technology.

Sulphur is one of the 16 elements essential for crop production (Marshner, 1995). Sulphur is considered as the fourth major nutrient element for crops (Platou and Jones, 1982). It is typically considered a secondary macronutrient (along with calcium and magnesium), but is essential for maximum crop yield and quality. Sulphur is often ranked immediately behind nitrogen, phosphorus and potassium in terms of importance to crop productivity (Krishnamoorthy, 1989 and Patil 1998). Sulphur is a component of the amino acids cysteine, cystine and methionine (Gangadhara et al., 1990 and Kumar and Yadav, 2007) making it essential for protein synthesis in plants. Plants also contain a large variety of other organic sulphur compounds such as glutathione. Sulphur is also a constituent of vitamins (thiamine and biotin), glycosides and co-enzyme A (Tisdale et al., 1985).

In recent years sulphur deficiency has become an increasing problem in agriculture. Saalbach (1973) reported maize yield loss to an extent of 10 to 30% and Pal and Singh (1992) upto 35% due to Sulphur deficiency. In general, cereals have high yield potential and low sulphur requirement. The sulphur requirement of cereals to produce one ton of cereals is low but uptake per unit area becomes almost equal to that of oilseeds mainly due to higher productivity of cereals (Sutar et al., 2017). Sulphur is an essential nutrient for all organisms due to its function in a large variety of processes (Gangadhara et al., 1990).

In the early 1990’s, sulphur deficiencies in Indian soils were estimated to occur in about 130 districts. More recently, soil fertility surveys by the ICAR system (analysis of 60,000 soil samples 2009) have shown sulphur deficiencies to be a wide spread problem. A soil is considered deficient in S if it tests less than 10 mg S/kg soil extractable with 0.15% CaCl\(_2\). Sulphur status of Indian soils is going down with each passing year. Close to 70% of soil samples analyzed by the ICAR system and TSI-FAI-IFA (The Sulphur Institute) project and other programs have been found to be either deficient or marginal in plant available sulphur. Soil analysis and crop response data generated by the TSI-FAI-IFA project (1997-2006) re-enforced the findings of the ICAR system. Based on reported results, out of over 49,000 soil samples
analyzed across 18 states, 46% of samples were deficient in sulphur and another 30% were medium in available sulphur which could be considered as potentially sulphur deficient. These data prove that sulphur deficiencies are a critical problem in 40-45% of districts translating into 57-64 million ha of net sown area.

Materials and Methods

A field experiment was carried out during kharif 2017 at College Farm, College of Agriculture, Rajendranagar, Hyderabad which is geographically situated at 17° 19’ N latitude and 78° 23’ E longitude and an altitude of 542.3 m above mean sea level. It is in the Southern Telangana agro-climatic zone of Telangana. According to Troll’s climatic classification, it falls under semi-arid tropics (SAT). The experimental site was sandy loam in texture with pH (60.8), EC (0.28dSm⁻¹), and OC (Low). The soil was low in available nitrogen (120 kg ha⁻¹) and available sulphur (21.2 kg ha⁻¹) and high in available phosphorus (74 kg ha⁻¹) and available potassium (308 kg ha⁻¹). Bulk density, porosity and moisture holding capacity were also determined by Keen’s cup method (initial and final). The experiment was carried out with three different sources of sulphur (Gypsum, Ammonium Sulphate and Bentonite Sulphur) and three levels (S @ 40 kg ha⁻¹, S @ 60 kg ha⁻¹ and S @ 80 kg ha⁻¹) and one source as urea, DAP and MOP and another source as urea, SSP and MOP comprising of eleven treatment combinations which were laid out in randomized block design and replicated thrice.

In all the treatments nitrogen was applied in two split doses 50% as basal and 50% as top dressing 45 DAS and entire dose of phosphorous, potassium and sulphur were applied as basal. Treatment T₁ was application of recommended dose of fertilizer i.e., N-P₂O₅-K₂O-S @ 200-60-50-60 kg ha⁻¹ without sulphur. Treatment T₂ was application of recommended dose of fertilizer through Urea, SSP and MOP. T₃ was T₁ + application of sulphur @ 40 kg ha⁻¹ through gypsum; T₄ was T₁+ application of sulphur @ 60 kg ha⁻¹ through gypsum; T₅ was T₁ + application of sulphur @ 40 kg ha⁻¹ through ammonium sulphate. T₆ was T₁ + application of sulphur @ 60 kg ha⁻¹ through ammonium sulphate. T₇ was T₁ + application of sulphur @ 80 kg ha⁻¹ through ammonium sulphate. T₈ was T₁ + application of sulphur @ 80 kg ha⁻¹ through ammonium sulphate. T₉ was T₁ + application of sulphur @ 40 kg ha⁻¹ through bentonite sulphur. T₁₀ was T₁ + application of sulphur @ 60 kg ha⁻¹ through bentonite sulphur. T₁₀ was T₁ + application of sulphur @ 80 kg ha⁻¹ through bentonite sulphur. Initial (30 DAS) and final (harvest) plant population was recorded. Plant samples were collected from gross plot to record dry matter production, plant height and LAI. To determine grain yield cobs from net plot were collected, sundried till 12% moisture attained and weighed. To determine stover yield stalk were harvested to ground level and sundried.

Results and Discussion

Initial and final plant population was taken at 30 DAS and harvest and was found non-significant when analysed statistically among the treatments. Plant height was non-significant at 30 DAS but at 60 DAS, 90 DAS and harvest T₂ and T₁₀ recorded highest values which were on par followed by T₄ and T₇. Lowest plant height was recorded by T₁ (Table 1). Different sources and levels of sulphur showed significant influence on LAI (Table 2) and TDM (Table 3) at 30 DAS, 60 DAS and harvest T₂ and T₁₀ recorded highest LAI and TDM values which were on par followed by T₄ and T₇. Least LAI and TDM was achieved by T₁.
Table 1. Plant height of maize (cms) at different stages as influenced by different sources and levels of Sulphur

| Treatments                                                                 | 30 DAS | 60 DAS | 90 DAS | Harvest |
|----------------------------------------------------------------------------|--------|--------|--------|---------|
| T1  Application of recommended dose of NPK through Urea, DAP and MOP       | 50.4   | 128.4  | 144.7  | 144.7   |
| T2  Application of recommended dose of NPK through Urea, SSP and MOP (sulphur supplied through SSP is 41.25 kg ha \(^{-1}\)) | 51.3   | 134.1  | 150.6  | 150.4   |
| T3  T1 + Application of Sulphur @ 40 kg ha \(^{-1}\) through gypsum         | 50.8   | 132.6  | 149.0  | 149.0   |
| T4  T1 + Application of Sulphur @ 60 kg ha \(^{-1}\) through gypsum         | 50.6   | 133.9  | 150.3  | 150.3   |
| T5  T1 + Application of Sulphur @ 80 kg ha \(^{-1}\) through gypsum         | 51.0   | 133.6  | 149.9  | 149.9   |
| T6  T1 + Application of Sulphur @ 40 kg ha \(^{-1}\) through Ammonium Sulphate | 50.7   | 132.4  | 148.9  | 148.9   |
| T7  T1 + Application of Sulphur @ 60 kg ha \(^{-1}\) through Ammonium Sulphate | 50.5   | 133.9  | 150.3  | 150.3   |
| T8  T1 + Application of Sulphur @ 80 kg ha \(^{-1}\) through Ammonium Sulphate | 50.7   | 133.5  | 150.1  | 150.1   |
| T9  T1 + Application of Sulphur @ 40 kg ha \(^{-1}\) through Bentonite Sulphur | 50.4   | 131.7  | 148.0  | 148.0   |
| T10 T1 + Application of Sulphur @ 60 kg ha \(^{-1}\) through Bentonite Sulphur | 51.7   | 134.6  | 151.0  | 151.0   |
| T11 T1 + Application of Sulphur @ 80 kg ha \(^{-1}\) through Bentonite Sulphur | 50.9   | 133.8  | 150.3  | 150.3   |
| S. E(m)  |        | 0.64   | 0.55   | 0.55   | 0.55    |
| CD (5%)    |        | NS     | 1.15   | 2.17   | 2.17    |
| Treatments                                                                 | 30 DAS | 60 DAS | 90 DAS | Harvest |
|----------------------------------------------------------------------------|--------|--------|--------|---------|
| **T1** Application of recommended dose of NPK through Urea, DAP and MOP   | 0.32   | 5.8    | 4.6    | 3.6     |
| **T2** Application of recommended dose of NPK through Urea, SSP and MOP (sulphur supplied through SSP is 41.25 kg ha\(^{-1}\)) | 0.40   | 6.4    | 5.2    | 4.2     |
| **T3** T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through gypsum  | 0.38   | 6.0    | 4.8    | 3.9     |
| **T4** T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through gypsum  | 0.40   | 6.3    | 5.1    | 4.2     |
| **T5** T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through gypsum  | 0.40   | 6.3    | 5.1    | 4.1     |
| **T6** T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Ammonium Sulphate | 0.38   | 6.0    | 4.7    | 3.9     |
| **T7** T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Ammonium Sulphate | 0.40   | 6.3    | 5.1    | 4.2     |
| **T8** T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Ammonium Sulphate | 0.40   | 6.3    | 5.1    | 4.1     |
| **T9** T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Bentonite Sulphur | 0.38   | 6.0    | 4.8    | 3.9     |
| **T10** T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Bentonite Sulphur | 0.41   | 6.5    | 5.2    | 4.2     |
| **T11** T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Bentonite Sulphur | 0.39   | 6.3    | 5.0    | 4.1     |

S. E(m)\(\pm\) 0.01 0.03 0.02 0.06

CD (5%) 0.02 0.45 0.36 0.13
| Treatments | 30 DAS | 60 DAS | 90 DAS | Harvest |
|------------|--------|--------|--------|---------|
| T₁ | Application of recommended dose of NPK through Urea, DAP & MOP | 10.2 | 80.0 | 126.2 | 138.2 |
| T₂ | Application of recommended dose of NPK through Urea, SSP & MOP (sulphur supplied through SSP is 41.25 kg ha⁻¹) | 13.3 | 89.3 | 129.3 | 141.3 |
| T₃ | T₁ + Application of Sulphur @ 40 kg ha⁻¹ through gypsum | 10.3 | 85.0 | 126.3 | 138.3 |
| T₄ | T₁ + Application of Sulphur @ 60 kg ha⁻¹ through gypsum | 12.3 | 87.3 | 128.3 | 140.3 |
| T₅ | T₁ + Application of Sulphur @ 80 kg ha⁻¹ through gypsum | 12.3 | 81.3 | 128.3 | 140.3 |
| T₆ | T₁ + Application of Sulphur @ 40 kg ha⁻¹ through Ammonium Sulphate | 10.3 | 87.7 | 126.3 | 138.3 |
| T₇ | T₁ + Application of Sulphur @ 60 kg ha⁻¹ through Ammonium Sulphate | 12.7 | 88.7 | 128.7 | 140.7 |
| T₈ | T₁ + Application of Sulphur @ 80 kg ha⁻¹ through Ammonium Sulphate | 12.3 | 86.7 | 128.3 | 140.3 |
| T₉ | T₁ + Application of Sulphur @ 40 kg ha⁻¹ through Bentonite Sulphur | 10.7 | 82.7 | 126.7 | 138.7 |
| T₁₀ | T₁ + Application of Sulphur @ 60 kg ha⁻¹ through Bentonite Sulphur | 13.3 | 89.3 | 129.3 | 141.3 |
| T₁₁ | T₁ + Application of Sulphur @ 80 kg ha⁻¹ through Bentonite Sulphur | 11.6 | 88.3 | 127.6 | 139.6 |
| S. Em. +/- | | | | |
| CD (5%) | 1.00 | 2.17 | 1.17 | 1.17 |
| Treatments | No of cobs plant-1 | No. of rows cob-1 | No. of grains row-1 | No of grains cob-1 |
|------------|--------------------|-------------------|---------------------|-------------------|
| T<sub>1</sub> | Application of recommended dose of NPK through Urea, DAP and MOP | 1.0 | 12.0 | 20.7 | 244.0 |
| T<sub>2</sub> | Application of recommended dose of NPK through Urea, SSP and MOP (sulphur supplied through SSP is 41.25 kg ha<sup>-1</sup>) | 1.0 | 13.3 | 23.7 | 306.0 |
| T<sub>3</sub> | T<sub>1</sub> + Application of Sulphur @ 40 kg ha<sup>-1</sup> through gypsum | 1.0 | 13.3 | 22.3 | 277.3 |
| T<sub>4</sub> | T<sub>1</sub> + Application of Sulphur @ 60 kg ha<sup>-1</sup> through gypsum | 1.0 | 13.3 | 22.7 | 302.7 |
| T<sub>5</sub> | T<sub>1</sub> + Application of Sulphur @ 80 kg ha<sup>-1</sup> through gypsum | 1.0 | 12.7 | 21.3 | 284 |
| T<sub>6</sub> | T<sub>1</sub> +Application of Sulphur @ 40 kg ha<sup>-1</sup> through Ammonium Sulphate | 1.0 | 13.3 | 22.3 | 281.3 |
| T<sub>7</sub> | T<sub>1</sub> +Application of Sulphur @ 60 kg ha<sup>-1</sup> through Ammonium Sulphate | 1.0 | 13.3 | 22.8 | 302.7 |
| T<sub>8</sub> | T<sub>1</sub> +Application of Sulphur @ 80 kg ha<sup>-1</sup> through Ammonium Sulphate | 1.0 | 12.7 | 22.6 | 286.7 |
| T<sub>9</sub> | T<sub>1</sub> +Application of Sulphur @ 40 kg ha<sup>-1</sup> through Bentonite Sulphur | 1.0 | 13.3 | 22.3 | 282.0 |
| T<sub>10</sub> | T<sub>1</sub> + Application of Sulphur @ 60 kg ha<sup>-1</sup> through Bentonite Sulphur | 1.0 | 13.3 | 24.0 | 320.0 |
| T<sub>11</sub> | T<sub>1</sub> + Application of Sulphur @ 80 kg ha<sup>-1</sup> through Bentonite Sulphur | 1.0 | 12.7 | 22.8 | 294.0 |
| S. E(m)+ | 0.0 | 0.7 | 0.7 | 18.1 |
| CD (5%) | NS | NS | 1.4 | 37.9 |
Table 5 Test weight (g), grain yield (kg ha\(^{-1}\)) and stover yield (kg ha\(^{-1}\)) of maize as influenced by different sources and levels of Sulphur

| Treatments                                                                 | Test weight (g) | Grain yield (kg ha\(^{-1}\)) | Stover yield (kg ha\(^{-1}\)) |
|---------------------------------------------------------------------------|-----------------|-------------------------------|-------------------------------|
| T\(_1\) Application of recommended dose of NPK through Urea, DAP & MOP    | 27.1            | 5477                          | 6792                          |
| T\(_2\) Application of recommended dose of NPK through Urea, SSP & MOP     | 31.3            | 5581                          | 6976                          |
| T\(_3\) T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through gypsum | 28.7            | 5527                          | 6908                          |
| T\(_4\) T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through gypsum | 31.1            | 5561                          | 6933                          |
| T\(_5\) T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through gypsum | 29.3            | 5550                          | 6930                          |
| T\(_6\) T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Ammonium Sulphate | 29.0            | 5519                          | 6898                          |
| T\(_7\) T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Ammonium Sulphate | 31.1            | 5561                          | 6950                          |
| T\(_8\) T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Ammonium Sulphate | 30.7            | 5552                          | 6945                          |
| T\(_9\) T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Bentonite Sulphur | 29.3            | 5518                          | 6898                          |
| T\(_10\) T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Bentonite Sulphur | 31.5            | 5596                          | 6995                          |
| T\(_11\) T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Bentonite Sulphur | 29.3            | 5561                          | 6993                          |
| S. E(m)\(\pm\)                                                           | 1.1             | 23.8                          | 29.71                         |
| CD (5%)                                                                  | 2.2             | 49.8                          | 62.09                         |
Table 6: Sulphur uptake (kg ha\(^{-1}\)) of maize in stover and seed as influenced by different sources and levels of Sulphur

| Treatments                                                                 | Sulphur | Sulphur uptake in stover and seed |
|----------------------------------------------------------------------------|---------|-----------------------------------|
|                                                                            | Stover  | seed                             |
| **T\(_1\)** Application of recommended dose of NPK through Urea, DAP and MOP | 12.15   | 5.67 17.82                       |
| **T\(_2\)** Application of recommended dose of NPK through Urea, SSP and MOP  | 12.88   | 10.24 23.12                       |
| (sulphur supplied through SSP is 41.25 kg ha\(^{-1}\))                       |         |                                  |
| **T\(_3\)** T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through gypsum | 13.21   | 10.03 23.24                       |
| **T\(_4\)** T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through gypsum | 16.34   | 14.25 30.59                       |
| **T\(_5\)** T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through gypsum | 15.90   | 13.26 29.16                       |
| **T\(_6\)** T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Ammonium Sulphate | 13.44   | 10.26 23.70                       |
| **T\(_7\)** T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Ammonium Sulphate | 16.42   | 14.38 30.80                       |
| **T\(_8\)** T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Ammonium Sulphate | 15.86   | 13.31 29.17                       |
| **T\(_9\)** T\(_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Bentonite Sulphur | 13.54   | 10.37 23.91                       |
| **T\(_{10}\)** T\(_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Bentonite Sulphur | 16.46   | 14.83 31.29                       |
| **T\(_{11}\)** T\(_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Bentonite Sulphur | 15.96   | 13.69 29.65                       |
| S. E(m)+                                                                   | 0.29    | 0.14 0.33                        |
| CD (5%)                                                                    | 0.61    | 0.29 0.69                        |
Table 7 Effect of different sources and levels of sulphur on economics

| Treatments | Cost of Cultivation (Rs. ha\(^{-1}\)) | Gross returns(Rs. ha\(^{-1}\)) | Net returns(Rs.ha\(^{-1}\)) | B:C ratio |
|------------|--------------------------------------|-------------------------------|-----------------------------|-----------|
| \(T_1\)   | Application of recommended dose of NPK through Urea, DAP and MOP | 22936.00                      | 77176.65                    | 50109.30  | 2.59     |
| \(T_2\)   | Application of recommended dose of NPK through Urea, SSP and MOP (sulphur supplied through SSP is 41.25 kg ha\(^{-1}\)) | 22869.57                      | 78623.80                    | 52154.23  | 3.04     |
| \(T_3\)   | \(T_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through gypsum | 23636.72                      | 77499.80                    | 50354.86  | 2.93     |
| \(T_4\)   | \(T_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through gypsum | 23698.88                      | 77537.27                    | 49983.59  | 2.92     |
| \(T_5\)   | \(T_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through gypsum | 24118.88                      | 77452.97                    | 48962.73  | 2.87     |
| \(T_6\)   | \(T_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Ammonium Sulphate | 24677.98                      | 77518.53                    | 50239.65  | 2.82     |
| \(T_7\)   | \(T_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Ammonium Sulphate | 25588.46                      | 77527.90                    | 49829.02  | 2.75     |
| \(T_8\)   | \(T_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Ammonium Sulphate | 26522.80                      | 77649.66                    | 49530.79  | 2.64     |
| \(T_9\)   | \(T_1\) + Application of Sulphur @ 40 kg ha\(^{-1}\) through Bentonite Sulphur | 25452.00                      | 79729.07                    | 51171.83  | 2.75     |
| \(T_{10}\) | \(T_1\) + Application of Sulphur @ 60 kg ha\(^{-1}\) through Bentonite Sulphur | 26178.00                      | 80139.34                    | 50236.60  | 2.71     |
| \(T_{11}\) | \(T_1\) + Application of Sulphur @ 80 kg ha\(^{-1}\) through Bentonite Sulphur | 27348.00                      | 79897.66                    | 48707.94  | 2.57     |
| S. E(m)±  | 275.00                                | 274.00                       | 0.01                         |
| CD (5%)    | 818.00                                | 813.98                       | 0.02                         |
Yield attributes *i.e.*, number of cobs plant$^{-1}$ and number of rows cob$^{-1}$ were non-significant when analysed statistically but number of grains row$^{-1}$ and number of grains cob$^{-1}$ were significant among different treatments. $T_2$ and $T_{10}$ recorded highest values which were on par followed by $T_4$ and $T_7$. Lowest data was recorded by $T_1$ (Table 4).

Highest grain (5596 kg ha$^{-1}$) and stover yield (6995 kg ha$^{-1}$) was recorded by treatment $T_{10}$ (S@60 kg ha$^{-1}$ through bentonite sulphur) followed by treatment $T_2$ (5581 and 6976 kg ha$^{-1}$) S@40 kg ha$^{-1}$ through urea, SSP and DAP. Treatments $T_7$ and $T_4$ were statistically on par with each other. Similarly treatments $T_3$, $T_5$ and $T_9$ were statistically on par with each other followed by $T_5$, $T_9$ and $T_{11}$ which were in turn on par (Table 5). Lowest grain (5477 kg ha$^{-1}$) and stover yield (6847 kg ha$^{-1}$) was recorded by $T_1$ which was non sulphur treatment.

Initial and final soil physico chemical properties like bulk density, porosity, maximum water holding capacity, soil texture, pH, Ec, OC were found non-significant when analysed statistically. Initial and final nutrient status of soil was also non-significant.

Highest sulphur uptake in stover and seed was noted by $T_{10}$ and lowest by $T_1$ (Table 6).

Highest gross returns were recorded by $T_{10}$ (Rs. 80139 ha$^{-1}$) followed by $T_2$ (Rs. 78623 ha$^{-1}$) though highest B: C ratio was recorded by $T_2$ because of higher cost of bentonite sulphur fertilizer (Table 7).

Highest growth and yield parameters were recorded by treatment $T_{11}$ followed by treatment $T_2$, but highest B: C ratio was recorded by treatment $T_2$. Variation in soil physico chemical properties was non-significant among different treatments but sulphur uptake studies indicate that uptake was highest at 60 kg ha$^{-1}$ and 80 kg ha$^{-1}$ which were statistically on par.

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**References**

Abbas, G., Hussain, A., Ahmad, A and Wajid, A. S. 2005. Effect of irrigation schedules and nitrogen rates on yield and yield components of maize. *Journal of agricultural and social sciences*. 1 (4): 335-338.

Binod Kumar, Govind Singh, Rajesh Kumar and Kamlesh Kumar Nishad.2016. Effect of nitrogen and sulphur nutrition on growth and yield of maize (*Zea mays* L.) under eastern plain zone of U.P. *Intl.J.Agric.Sci.*, 12(2): 181-185.

Channabasamma, A., Habsur, N. S., Bangaremma, S. W and Akshaya, M. C. 2013. Effect of nitrogen and sulphur levels and ratios on growth and yield of maize. *Molecular Plant Breeding*. 37 (4): 292-296.

Gangadhara, G. A., Manjunathaih, H. M and Satyanarayana, T. 1990. Effect of sulphur on yield, oil content of sunflower and uptake of micronutrients by plants. *Journal of Indian Society of Soil Science*. 38(4): 692-694.

Krishnamoorthy, S. K. 1989. Sulphur fertilization for yield and quality of crops. *Proc. National seminar on Sulphur in Agriculture*, held at UAS, Bangalore. Pp 22-25.
Kumar, H. and Yadav, D. S. 2007. Effect of phosphorus and sulphur level on growth, yield and quality of Indian mustard (Brassica juncea L.) cultivars. Indian Journal of Agronomy. 52(2): 154-157.

Marschner, H. 1995. Mineral Nutrition of Higher Plants (2nd Ed.). Academic Press, London.

Rahul K. Sutar, Amit M. Pujar, Aravinda Kumar B.N. and Hebsur N.S. 2017. Sulphur nutrition in maize a critical review. Int. J. Pure App. Biosci. 5(6): 1582-1596.

Saalbach, E. 1973. The effect of S, Mg and Na on yield and quality of agriculture crop. Pontifical Academical Scientiarum Scripa Varia. 38: 451-538.

Tisdale, S. L., Nelson, W. L and Beaton, J. D. 1985. Soil Fertility and Fertilizers; Macmillan Publishing Company: New York, 75-79.

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