



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; SP-8(11): 413-416
Received: 29-09-2025
Accepted: 30-10-2025

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Effect of Sulphur and Sulphur Oxidizing Bacteria (SOB) on Chlorophyll Content and Biological Property of Soil (SOB count) in Chickpea

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DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i11Sf.4293>

Abstract

A pot experiment was conducted during *Rabi* 2023-24 at Department of Soil Science and Agricultural Chemistry, JAU, Junagadh to assess the Effect of sulphur and sulphur oxidizing bacteria (SOB) on chlorophyll content and biological property of soil (SOB count) in chickpea. The application of sulphur at 20 kg/ha (S_3) and application of 1.5 lit SOB/ha (SOB_3) found higher result in case of chlorophyll content at 45 DAS 2.96 (mg/g) and 2.90 (mg/g), respectively. The application of 2.0 lit SOB/ha significantly increased sulphur oxidizing bacterial populations at 45 DAS and at harvest in soil 2.33 (10^6 cfu/g soil) and 3.70 (10^6 cfu/g soil), respectively. While, sulphur application did not produce any significant effect on sulphur oxidizing bacterial populations in soil at 45 DAS and at harvest of chickpea.

Keywords: Chickpea, *Rabi*, sulphur, SOB, chlorophyll and SOB count

Introduction

India is the largest producer of gram in the world sharing 65% and 70% of total global area and production, respectively. Chickpea (*Cicer arietinum* L.) is an essential annual pulse crop that belongs to the genus: *Cicer*, Family: Leguminosae or Fabaceae and is also recognized as “Bengal gram”. It is the third largest legume produced in worldwide. For millions of people, it is a source of plant protein.

Chickpea is grown all over the world, with the largest production in India, Australia, Myanmar, Pakistan, Turkey, Ethiopia. In India, chickpea cover 10.91 million hectares area and produce 13.75 million tonnes (Anonymous, 2022).^[1] Chickpea solely contributes nearly 50% of the Indian pulse production. States like Maharashtra (25.97% contribution to national production), Madhya Pradesh (18.59%), Rajasthan (20.65%), Gujarat (10.10%) and Uttar Pradesh (5.64%) are major chickpea producing states of India.

In Gujarat, gram was cultivated in about 1.61 lakh hectares area with total annual production of about 1.99 lakh tonnes and average productivity of 1330 kg/ha during 2014-15. Gram is grown in almost all the districts of Gujarat except Dang. The cultivation of gram is predominantly centered in Bhal region consisting of Ahmedabad, Surendranagar, Bhavnagar, Kheda districts, Ghed region of Porbandar and in Godhra and Dahod districts.

Sulphur is the element which contributes to the formation of protein and among all the nutrients. In India, sulphur is deficient more than 41% as the soil is the major supplier of sulphur to plants. For plant's growth and development, sulphur is very important as it helps in the formation of proteins, enzymes, vitamins and chlorophyll and also in nodule formation and nitrogen fixation. In 1990's, it was estimated that soils in about 130 districts of India were suffering from some degree of sulphur deficiency (Tandon, 1991).^[5] Sulphur as secondary plant nutrient is becoming increasingly important in dryland agriculture as it is the “Master Nutrient” for all oilseed crops and pulses and is rightly being called the “Forth Major Plant Nutrient”, along with nitrogen, phosphorus and potassium. Sulphur performs many important functions in the plant. It is best known for its role in the synthesis of proteins, oils and vitamins. It is a constituent of three amino acids viz., methionine, cysteine and cystine.

Certain types of bacteria are able to oxidize reduced form of sulphur which is unavailable to

plants into available form. These types of bacteria are called as sulphur oxidizing bacteria (SOB). One of the best examples of SOB is a genus *Thiobacillus*, i.e. *Thiobacillus thiooxidans*, *Thiobacillus ferrooxidans*, *Thiobacillus thioparus*, *Thiobacillus novellus*. The SOB generally improves the production or the conversion of the elemental sulphur to the sulphate (SO_4^{2-}) for absorption and results in the plant growth promotion and production process. Because of applying sulphur oxidizing bacteria (SOB) to soils, an amount of available sulphur to the plant is increased, it helps to enhance the pulse seed production and productivity.

2. Materials and Methods

The experiment was conducted during *Rabi*, 2023-24 in the Net House of Department of Soil Science and Agricultural

Chemistry, College of Agriculture, Junagadh Agricultural University, Junagadh. The soil of the experimental pot was clayey in texture and alkaline in reaction with pH 8.10 and EC 0.46 dSm^{-1} . The soil was medium in available nitrogen (323.0 kg/ha), medium in available phosphorus (53.9 kg/ha), medium in available potash (263.8 kg/ha) and medium in available sulphur (12.6 ppm).

There were different levels of sulphur and SOB application. Levels of Sulphur: S_1 : 00 kg S/ha , S_2 : 10 kg S/ha and S_3 : 20 kg S/ha . While, levels of SOB: SOB_1 : 0.0 lit SOB/ha , SOB_2 : 1.0 lit SOB/ha , SOB_3 : 1.5 lit SOB/ha and SOB_4 : 2.0 lit SOB/ha that replicated thrice in Factorial CRD. In this study, chlorophyll content was recorded at 45 DAS and biological property of soil (SOB count) was recorded at 45 DAS and at harvest. And 12 treatment combination are listed below,

Table 1: Treatment Combination

Treat. No.	Treatment Combination	Level of sulphur (Cosavet) kg/ha	Level of SOB (lit/ha)
T ₁	S ₁ SOB ₁	0.00	0.00
T ₂	S ₁ SOB ₂	0.00	1.00
T ₃	S ₁ SOB ₃	0.00	1.50
T ₄	S ₁ SOB ₄	0.00	2.00
T ₅	S ₂ SOB ₁	10.0	0.00
T ₆	S ₂ SOB ₂	10.0	1.00
T ₇	S ₂ SOB ₃	10.0	1.50
T ₈	S ₂ SOB ₄	10.0	2.00
T ₉	S ₃ SOB ₁	20.0	0.00
T ₁₀	S ₃ SOB ₂	20.0	1.00
T ₁₁	S ₃ SOB ₃	20.0	1.50
T ₁₂	S ₃ SOB ₄	20.0	2.00

3. Results and Discussion

3.1 Chlorophyll content (DMSO method) at 45 DAS

The result indicated that different level of sulphur produced significant effect on chlorophyll content of chickpea. Significantly higher chlorophyll content (2.96 mg/g) at 45 DAS that registered with application of sulphur at 20 kg/ha (S_3), which was statistically at par with application of sulphur at 10 kg/ha (S_2). On the other hand, significantly the lowest chlorophyll content (2.35 mg/g) was noted under control treatment (S_1). Similar results were observed by Gawhale *et al.* (2024) [3] that total chlorophyll (1.012 mg/g) was noticed with the application of Bentonite sulphur @ 30 kg/ha in chickpea.

Effect of sulphur oxidizing bacteria (SOB)

The data presented in revealed that various levels of sulphur oxidizing bacteria significantly influenced chlorophyll content in chickpea at 45 DAS. The application of 1.5 lit SOB/ha (SOB_3) recorded significantly chlorophyll content (2.90 mg/g) at 45 DAS. Whereas, it was also at par with 2 lit SOB/ha (SOB_4). The lowest chlorophyll content (2.41 mg/g) was observed under control treatment (SOB_1). Similar results were observed by Chaudhary *et al.* (2019) [2] that sulphur oxidizing bacteria promote growth of mustard and also increase chlorophyll content.

Interaction effect of sulphur and SOB

The interaction effect of sulphur and sulphur solubilizing bacteria on chlorophyll content in chickpea was found non-significant.

3.2 Biological property of soil (SOB count) at 45 DAS and at

harvest

Effect of sulphur (S)

A perusal of data showed that different levels of sulphur exerted their non-significant influence on sulphur oxidizing bacteria population in soil at 45 DAS and at harvest of chickpea.

Effect of sulphur oxidizing bacteria (SOB)

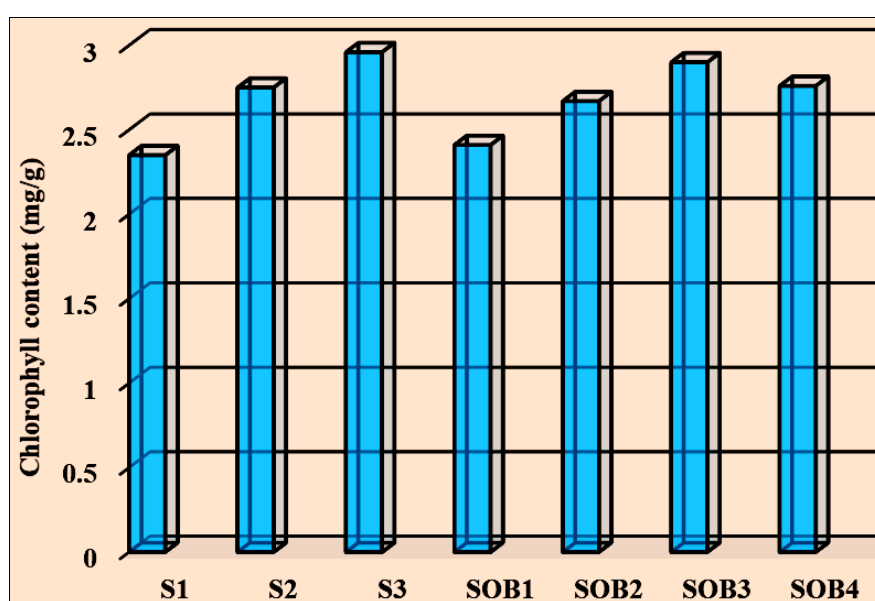
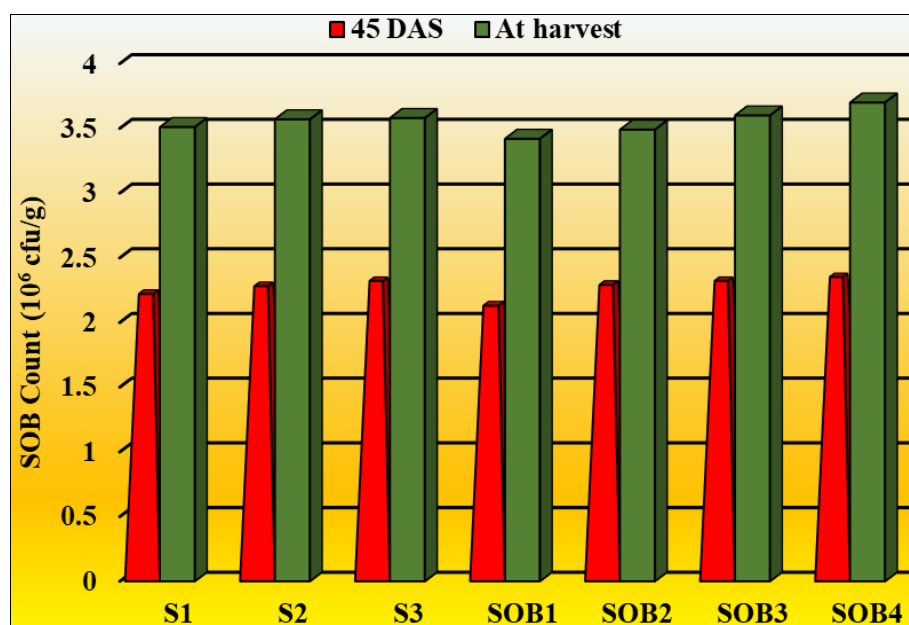
An examination of data revealed that different levels of SOB executed their significant influence on SOB population in soil at 45 DAS and at harvest of chickpea. Application of 2.0 lit SOB/ha (SOB_4) recorded significantly higher sulphur oxidizing bacteria population ($2.33 \times 10^6 \text{ cfu/g}$) and ($3.70 \times 10^6 \text{ cfu/g}$) in soil at 45 DAS and at harvest of chickpea, respectively. Whereas, it was at par with 1.5 lit SOB/ha (SOB_3) at 45 DAS and at harvest of chickpea. While, significantly the lowest sulphur oxidizing bacteria population ($2.11 \times 10^6 \text{ cfu/g}$) and ($3.42 \times 10^6 \text{ cfu/g}$) at 45 DAS and at harvest of chickpea were recorded under control treatment (SOB_1), respectively. Microbes decompose the organic material and release different nutrients and organic carbon into soil. Due to this reason significantly increase bacterial population by absorbing these nutrients and favourable environment increase multiplication rate of bacteria in soil. These results were also in agreement with Kaur *et al.* (2020) [4] in mustard that application of microbial inoculants significantly improved the soil biological (in term microbial population and their activities) and soil chemical (available nutrients) properties of soil.

Interaction effect of sulphur and SOB

The interaction effect of different levels of sulphur and sulphur oxidizing bacteria did not produce any significant effect in respect of sulphur oxidizing bacteria population in soil at 45 DAS and at harvest of chickpea.

Table 2: Effect of sulphur and SOB levels on chlorophyll content at 45 DAS and SOB count in soil at 45 DAS and at harvest of chickpea

Treatment	Chlorophyll (mg/g) 45 DAS	SOB (10 ⁶ cfu/g soil)	
		45 DAS	At harvest
Sulphur levels (kg S/ha)			
S ₁ - 0	2.35	2.20	3.51
S ₂ - 10	2.75	2.26	3.57
S ₃ - 20	2.96	2.30	3.58
S.Em.±	0.07	0.03	0.04
C.D. at 5 %	0.21	NS	NS
SOB levels (Lit SOB/ha)			
SOB ₁ - 0	2.41	2.11	3.42
SOB ₂ - 1.0	2.67	2.27	3.49
SOB ₃ - 1.5	2.90	2.30	3.60
SOB ₄ - 2.0	2.76	2.33	3.70
S.Em.±	0.08	0.04	0.05
C.D. at 5 %	0.25	0.10	0.15
Interaction (S × SOB)			
S.Em.±	0.15	0.06	0.09
C.D. at 5 %	NS	NS	NS
C.V. %	9.47	4.68	4.29

**Fig 1:** Effect of sulphur and SOB levels on chlorophyll content at 45 DAS of chickpea**Fig 2:** Effect of sulphur and SOB levels on SOB count in soil at 45 DAS and at harvest of chickpea

4. Conclusion

From the forgoing results and discussion, it can be concluded that chlorophyll content and biological property of soil (SOB count) were adversely affected due to application of sulphur and SOB. Significantly higher chlorophyll content (2.96 mg/g) at 45 DAS that registered with application of sulphur at 20 kg/ha (S_3) and the application of 1.5 lit SOB/ha (SOB_3) recorded higher chlorophyll content (2.90 mg/g) at 45 DAS. While, sulphur oxidizing bacteria populations in soil did not influence by sulphur application at 45 DAS and at harvest. The bacterial populations at 45 DAS and at harvest were significantly higher with value (2.33×10^6 cfu/g and 3.70×10^6 cfu/g) under application of 2.0 lit SOB/ha (SOB_4).

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