International Journal of Research in Agronomy 2025; 8(12): 1072-1075

E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 1072-1075
Received: 13-10-2025
Accepted: 17-11-2025

Prahalad Kumar Prajapat
Agriculture Officer, Department of Agriculture, Government of Rajasthan, Rajasthan, India

NK Pareek
Associate Professor (Agronomy), College of Agriculture, Fatehpur-Shekhawati, Sikar, SKNAU, Jobner, Rajasthan, India

Ashish Raja Jangid
Department of Agronomy, Rajasthan Collage of Agriculture, MPUAT, Udaipur, Rajasthan, India

Arun Pratap Singh
KVK (ICAR-IIVR), Kushinagar, Uttar Pradesh, India

Arun C Kanagalabavi
Assistant Professor, Department of Soil Science, KLE College of Agricultural Sciences, Belagavi, UAS, Dharwad, Karnataka, India

Mahesh M Mahale
KVK (DBSKKV), Ratnagiri, Maharashtra, India

Corresponding Author:
Arun Pratap Singh
KVK (ICAR-IIVR), Kushinagar, Uttar Pradesh, India

Productivity, profitability and sulphur status in soil after harvest of crop as affected by different sulphur levels and application methods

Prahalad Kumar Prajapat, NK Pareek, Ashish Raja Jangid, Arun Pratap Singh, Arun C Kanagalabavi and Mahesh M Mahale

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12o.4546

Abstract
An experiment was carried out at Agronomy farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *rabi*, 2019-20 to find out the response of chickpea (*Cicer arietinum* L.) to different sulphur levels and application methods under irrigated conditions of Rajasthan". The experiment was laid out in split plot design with three replications assigning four levels of basal application of sulphur (0, 20, 40 and 60 kg ha^{-1}) in main plots and four concentrations of foliar spray of liquid sulphur (0, 0.1, 0.2 and 0.3% sulphur) at 65 and 75 DAS in sub plots. The findings indicate that basal sulphur applications of 40 kg ha^{-1} had significant effects on seed and straw yield, available sulphur in soil, net return as well as B:C ratio over control and basal sulphur applications at 20 kg ha^{-1}, which was being at par with basal sulphur applications at 60 kg ha^{-1}. The seed and straw yield, net return as well as B:C ratio significantly increased with foliar spray of liquid sulphur (0.2%) over control and foliar spray of liquid sulphur (0.1%), which was being at par with foliar spray of liquid sulphur (0.3%).

Keywords: Foliar spray of silphur, chickpea, sulphur levels, economics and yield

Introduction
Chickpeas (*Cicer arietinum* L.) are the third most significant legume for winter nourishment. It is the main pulse crop grown in India, and in dry and semi-arid areas, it is mostly farmed on a large scale during the rabi season. It is used to manufacture dal and flour (besan), which are both ingredients in numerous dishes and culinary items. Chickpeas hold a major position among leguminous crops due to their excellent nutritional value, high biological value, and strong digestion of their 17-23% protein content. It also has considerable levels of carbohydrates, minerals (Ca, P, Mg, and K), and other vitamins (Jukanti *et al*., 2012) [5], in addition to riboflavin, niacin and thiamine.

Even yet, despite having a relatively low protein content, chick peas have a higher biological value and easier digestion than other pulses. In chickpeas, there is a sizeable amount of protein, carbohydrates, and nutritionally important unsaturated fatty acids including linoleic and oleic acids (Hirdyani, 2014) [4]. The pharmaceutical industry makes use of the malic and oxalic acids contained in chickpea leaves and pods (Rathore, 2014) [12]. Its grains are used to cleanse the blood, and sprouted chickpeas are also advised for the treatment of scurvy. To assist the production of milk, meat, and/or eggs, chickpea grains are also used as a high-energy and protein-rich animal feed. Ruminant diets can also include chickpea straw as an alternative source of fodder (Bampidis and Christodoulou, 2011) [2].

Sulphur, the fourth major plant nutrient and a secondary essential element, is a crucial component of several essential amino acids, including methionine, cystine and cysteine, and hence plays a crucial role in the metabolism of plants. One of sulphur's principal functions is the formation of disulphide bonds between polypeptide chains, which is essential for preserving and controlling the conformation of proteins. Glutathione, Co enzyme A, biotin, thiamine, and vitamin B synthesis depend on it. Additionally, according to Tisdale *et al*. (2014) [17], it is essential for the synthesis of chlorophyll in green plants and helps produce nodules in pulses.

Since pulses are particularly vulnerable to sulphur shortage, which reduces the quality and productivity of pulses, sulphur is one of the most important essential plant nutrients for pulses. The majority of chickpea production takes place on poor, marginal soils. Sulphur and other nutrients are severely lacking in the soils of the Bikaner district. 20-40% of the soils in the Bikaner district are found to have sulphur concentrations that are lower than the 10 ppm criteria (Anonymous, 2019) [1]. Crops grown on coarse textured soils are often more vulnerable to sulphur shortage due to the low amounts of organic matter and SO_4^{-2} ion leaching. Irrigation and rains aggravate the losses in these soils. In certain situations, it could be necessary to use SO_4^{-2} fertilisers more frequently. Sulphur deficiency in soils and plants was eventually accelerated by increased agricultural activities and management practises, including the use of high yielding varieties, multiple cropping, irrigation, and application of higher rates of other plant nutrients. Lack of available sulphur in the soil was results in low-quality and lower yields. As a result, the soils' sulphur shortage needs to be addressed. Treatment options for sulphur deficiency include foliar sprays of liquid sulphate or other sulfate-containing fertilisers as well as basal dose additions of sulphate from a variety of sources.

Materials and Methods

The field investigation was carried out at Agronomy Farm, Department of Agronomy, College of Agriculture, SKRAU, Bikaner (Rajasthan) during *rabi* season of 2019-20 to evaluation the "Response of Chickpea *(Cicer arietinum* L.) to Different Sulphur Levels and Application Methods under Irrigated Conditions of Rajasthan". The Agronomy Farm is situated at 28.01^0N latitude and 73.35^0E longitude and at an altitude of 235 m above msl. There were all the facilities to cultivation of crops provided by Department of Agronomy, College of Agriculture, SKRAU, Bikaner. The sandy loam texture of the experimental field soil had a pH of 8.5, which was slightly alkaline in reaction, very low amount of organic carbon (0.109%), very low in available nitrogen (89.21 kg ha^{-1}), low in available phosphorus (19.1 kg ha^{-1}), medium in available potassium (190.5 kg ha^{-1}) and low in available sulphur (16.35 kg ha^{-1}). On November 7, 2019, the crop was sown with GNG 1958 (Marudhar). There were three replications and sixteen treatments combinations {four levels of basal application of sulphur (0, 20, 40 and 60 kg ha^{-1}) in main plots and four concentrations of foliar spray at 65 and 75 DAS of liquid sulphur (0, 0.1, 0.2 and 0.3% sulphur) in sub plots}, which were laid out in split plot design.

Gypsum was used as the basal dose for the application of sulphur during field preparation in the main plots, while liquid sulphur was applied twice, once at 65 DAS and once at 10 days after the initial application (75 DAS), in the sub plots, in accordance with the treatments, using 500 litres of water ha^{-1}. In main plot- gypsum application rates of 108, 216 and 324 kg ha^{-1} were determined according to the treatments (20, 40, and 60 kg ha^{-1}) and spread before sowing being mixed into the soil with a tractor-drawn rotavator. No sulphur was added to control plots. In sub plot- commercial liquid sulphur (40% S) used for preparation solutions of the desired liquid sulphur concentrations (0.1, 0.2 and 0.3%) were made and sprayed in the designated plots for the appropriate treatments. There was no foliar application of liquid sulphur in the plots under control. Application of fertilizer as per recommendation i.e., 20 kg N, 40 kg P_2O_5 and 20 kg K_2O ha^{-1} were applied as basal through urea, DAP and MOP, respectively. The entire quantity of P_2O_5 was delivered through DAP. Thus, the amount of nitrogen that had previously been supplied through DAP was determined, and in accordance with the remaining nitrogen, urea was used to supply the remaining nitrogen.

After the pre-season pearl millet crop is harvested, the field needs to be cross-cultivated using a tractor-drawn cultivator. Both a harrowing and planking were done to prepare the field. For one hectare of land, 80 kg of seeds were used for the sowing process, and three irrigations were then given via sprinkler system as and when necessary to encourage the best growth, development, and yield of chickpea. To lessen crop weed competition, two hand weeding were carried out at 22 DAS (November 30, 2019) and 15 days following the initial weeding (December 15, 2019). Quinalphos 25% EC @ 1 litre *a.i.* ha^{-1} was prepared in 500 litres of water ha^{-1} and sprayed on February 26, 2020, to control pod borer. When the crop achieved physiological maturity and the plant turned yellow, it was harvested from the net plot.

The weight of the seeds collected from each plot was measured after harvest and threshing, and the seed yield was then converted to kg ha^{-1}. The straw yield (kg ha^{-1}) was calculated by subtracting the biological yield (kg ha^{-1}) from the seed yield (kg ha^{-1}).

To analyse the nutrients in the soil, samples were taken from a depth of 15 cm and crushed to pass through a 2 mm sieve. The available sulphur in the soil was extracted by0.15% $CaCl_2$ solution. The extracted sulphur was measured in ppm using a turbidimetric method and a spectrophotometer and translated into kg sulphur ha^{-1}.

On the basis of market prices (experiment carried out time) for inputs and outputs, the economics of various treatments were calculated in terms of net returns (₹ ha^{-1}) and B:C ratio.

The traditional procedure given by Fisher and Yates (1950) [3] was followed by using the technique of analysis of variance for split plot design to look into the significance of the data. When the "F" test indicated significance at the 5% level of probability, the crucial differences were computed to evaluate the importance of differences between the treatments.

Basal application of sulphur

Yield

The basal application of sulphur (40 kg ha^{-1}) exhibited a significant increase in seed, straw and biological yield compared to control and basal application of sulphur at 20 kg ha^{-1}, respectively, which were on par with basal sulphur applications of 60 kg ha^{-1} (Table 1). Early and abundant sulphur availability to plants influenced seed size and development favourably, which in turn increased the number of pods and test weight. Since test weight and pods $plant^{-1}$ are yield parameters, a significant improvement in these attributes may have led to a significantly higher chickpea seed output. The findings of Mir *et al.* (2013) [8] in blackgram, Srinivasulu *et al.* (2015) [15] in chickpea and Shukla *et al.* (2023) [13] in chickpea closely support the existing trend of increased grain production brought on by basal sulphur application. As a result, a considerable rise in grain and straw yield could be attributed to the application of sulphur, which significantly increased biological yield. Harvest index remained unchanged with application of sulphur.

Economics

Experimental results show that basal applications of sulphur up to 40 kg ha^{-1} enhanced net return & B:C ratio, reflecting percentage improvements to the extent of 46.14 and 17.16 per cent & 24.3 and 10.6 per cent over control and basal applications of sulphur @ 20 kg ha^{-1}, which were on par with basal sulphur applications of 60 kg ha^{-1}. Higher net returns and a better B:C ratio must follow from the application of sulphur, which significantly increased seed and straw yield. These results support those from Muniswamy *et al*. (2015) [9], Sunil *et al*. (2017) [16] and Singh *et al*. (2018) [14].

Sulphur content in soil

The available sulphur status after harvest of chickpea crop was significantly enhanced with basal applications of sulphur at 40 kg ha^{-1} by 75 and 11.7 per cent as compared to control and basal application of sulphur at 20 kg ha^{-1}, respectively. This might be due to the gypsum in the soil kept adding more and more sulphur, which increased the amount of sulphur in the soil. Patel *et al*. (2014) [10] and Phogat *et al*. (2018) [11] reported similar findings.

Foliar spray of liquid sulphur

Yield

Data in presented Table 1 shows that foliar spraying with liquid sulphur (0.2%) considerably boosted yield, including seed, straw and biological compared to control and foliar spraying of sulphur (0.1%), which was at par with foliar spraying with sulphur (0.3%). The cumulative effects of improvements in photosynthesis, growth factors and improved partitioning potential brought about by foliar spraying with liquid sulphur must be improved yield characteristics and seed production. Due to the fact that dry matter accumulation and plant height are the main factors influencing plant growth, improvements in these growth parameters resulted in improved straw output. These conclusions are supported by Khalid *et al*. (2016) [6] in *Brassica napus* and Lakshmi *et al*. (2017) [7] in blackgram. Therefore, a considerable increase in grain and straw yield with foliar spray of sulphur could be attributed to a significant increase in biological yield. Harvest index remained unchanged with application of sulphur.

Economics

The net return was significantly improved by 37.1 and 14.5 per cent, B:C ratio was significantly improved by 15.4 and 6.98 per cent with foliar spray of liquid sulphur (0.2%) as compared to control and foliar spray of liquid sulphur (0.1%), respectively. The increase in seed and straw yield with these treatments could potentially be used to explain this. Lakshmi *et al*. (2017) [7] published similar findings in blackgram.

Sulphur content in soil

All levels of foliar spraying liquid sulphur did not significantly differ in terms of the status of available sulphur in soil after harvest of chickpea. This might be due to foliar of spray of sulphur on surface of plant, direct absorbed by plant. Thus, sulphur content was not reached soil.

Table 1: Effect of sulphur levels and application methods on yield, economics and sulphur content in soil after harvest of chickpea

Treatments	Yield (kg ha^{-1})			Harvest index (%)	Economics		Sulphur content in soil (kg ha^{-1})
	Grain	Straw	Biological		Net returns (₹ ha^{-1})	B:C ratio	
Basal application of sulphur (kg ha^{-1})							
Control	1551	2725	4275	36.1	54813	2.76	12.0
20	1826	3019	4844	37.6	68372	3.10	18.8
40	2053	3292	5345	38.3	80104	3.43	21.0
60	2163	3417	5580	38.8	85455	3.55	21.7
SEm ±	55	77	114	0.7	2891	0.09	0.50
CD (p=0.05)	189	266	395	NS	10005	0.31	1.72
Foliar spray of liquid sulphur							
Control	1579	2758	4337	36.3	57561	2.92	18.2
0.1%	1830	3033	4863	37.5	68947	3.15	18.5
0.2%	2038	3279	5318	38.2	78921	3.37	18.2
0.3%	2144	3382	5526	38.8	83315	3.41	18.6
SEm ±	56	75	92	0.9	2870	0.09	0.38
CD (p=0.05)	164	219	270	NS	8376	0.25	NS

Conclusion

Based on the results of our one-year experiment, it can be concluded that the basal application of sulphur (40 kg ha^{-1}) and foliar application of sulphur (0.2%) recorded the maximum yield and economics (net return and B:C ratio), these treatments may be more preferred by farmers because they are economically more profitable and can, therefore, be suggested to farmers.

References

1. Anonymous. The Sulphur Institute. Washington (USA): The Sulphur Institute; 2019. https://www.sulphurinstitute.org
2. Bampidis V, Christodoulou V. Chickpeas (*Cicer arietinum* L.) in animal nutrition: a review. Anim Feed Sci Technol. 2011;168:1-20.
3. Fisher RA, Yates F. Statistical tables for biological, agricultural and medical research. 6th ed. London: Pearson Education Ltd.; 1950.
4. Hirdyani H. Nutritional composition of chickpea (*Cicer arietinum* L.) and value-added products: a review. Indian J Community Health. 2014;26(2):102-106.
5. Jukanti AK, Gaur PM, Gowda CLL, Chibbar RN. Nutritional quality and health benefits of chickpea (*Cicer arietinum* L.): a review. Br J Nutr. 2012;108(Suppl 1):S11-S26.
6. Khalid S, Afridi MZ, Munsif F, Ullah I. Effect of sulphur foliar application on yield and yield components of Brassica napus. Int J Agric Environ Res. 2016;2(3):232-236.
7. Lakshmi EJ, Rameshbabu PV, Reddy GP, Maheswari PU, Reddy APK. Effect of foliar application of secondary nutrients and zinc on growth and yield of blackgram. Int J Chem Stud. 2017;5(6):944-947.
8. Mir AH, Lal SB, Salmani M, Abid M, Khan I. Growth, yield and nutrient content of blackgram (Vigna mungo) as influenced by levels of phosphorus, sulphur and phosphorus solubilizing bacteria. SAARC J Agric. 2013;11(1):1-6.
9. Muniswamy RS, Singh V, Mithare P. Response of nitrogen, sulphur and foliar application of zinc on yield and quality of greengram (*Vigna radiata* L.). J Pharmacogn Phytochem. 2018;7(3):517-522.
10. Patel HK, Patel PM, Suthar JV, Patel MR. Yield, quality

and post-harvest nutrient status of chickpea as influenced by sulphur and phosphorus fertilizer management. Int J Sci Res Publ. 2014;4(7):1-5.
11. Phogat M, Rai AP, Kumar S. Interaction effect of phosphorus and sulphur application on nutrient uptake, yield and yield attributing parameters of blackgram [*Vigna mungo* (L.) Hepper]. Legume Res. 2018.
12. Rathore PS. Techniques and management of field crop production. Jodhpur (India): Agrobios; 2014. p. 223.
13. Shukla A, Mishra A, Mishra US, Sirothia P, Singh OK, Jendre A. Effect of sulphur and vermicompost on growth parameters, yield attributes and yield of chickpea. Int J Plant Soil Sci. 2023;35(20):602-608.
14. Singh R, Tej Pratap, Singh D, Singh G, Singh AK. Effect of phosphorus, sulphur and biofertilizers on growth attributes and yield of chickpea (*Cicer arietinum* L.). J Pharmacogn Phytochem. 2018;7(2):3871-3875.
15. Srinivasulu DV, Solanki RM, Kumari CR, Babu MVS. Nutrient uptake, yield and protein content of chickpea (*Cicer arietinum* L.) as influenced by irrigation and sulphur levels in medium black soils. Int J Agric Sci. 2015;11(1):54-58.
16. Sunil, Dahiya S, Bhattoo MS, Khedwal RS. Effect of zinc and sulphur on growth, yield and economics of clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.]. Int J Curr Microbiol Appl Sci. 2017;6(11):3744-3751.
17. Tisdale SL, Havlin JL, Nelson WL, Beaton JD. Soil fertility and fertilizers: an introduction to nutrient management. New Delhi: PHI Learning Pvt. Ltd.; 2014. p. 242.