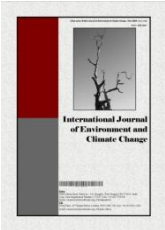

*International Journal of Environment and Climate Change*

***12(11): 707-713, 2022; Article no.IJECC.89960***
***ISSN: 2581-8627***
*(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)*

# Influence of Biofertilizers and Sulphur on Growth and Yield Attributes of Chickpea (*Cicer arietinum* L.)

**Devarapalli Sathvik [a*ϕ] and Victor Debbarma [a#]**

*[a] Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj, Uttar Pradesh, 211007, India.*

***Authors' contributions***

*This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.*

***Article Information***

DOI: 10.9734/IJECC/2022/v12i1131028

**Open Peer Review History:**
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/89960

***Original Research Article***

***Received 16 May 2022***
***Accepted 21 July 2022***
***Published 25 July 2022***

## ABSTRACT

A field experiment was conducted during *Rabi* season 2021-22 at the experimental field of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology And Sciences, Prayagraj, Uttar Pradesh. India which is located at $25^0$ 30' 42''N latitude, $81^0$ 60' 56" E longitude, and a height of 98 meters above sea level. The Experiment was laid out in Randomized Block Design with 9 treatments replicated thrice based on one year of experimentation. Biofertilizers like Rhizobium (25g/kg seeds), PSB (25g/kg seeds), Rhizobium(12.5g/kg seeds) + PSB (12.5g/kg seeds) along with different levels of Sulphur – 15,20 and 25kg/ha were used as treatments. The results revealed that significantly higher plant height (59.3cm), maximum number of Nodules/plant (7.8) and higher plant dry weight (66.3g). Whereas the maximum number of pods/plant (67.6),higher seeds/pod (2.8), maximum seed index (28.00 g),higher seed yield (1748.8 kg/ha), higher stover yield (2957.8 kg/ha) were recorded in the treatment- 9[Rhizobium(12.5g/kg seeds )+ PSB(12.5 g/kgseeds) + Sulphur ( 25kg/ha)].

*Keywords: Chickpea; rhizobium; PSB; sulphur; growth and yield.*

---

*ϕ M.Sc. Scholar;*
*# Assistanat Professor;*
**Corresponding author: E-mail: sathvikmithra123@gmail.com, 20msagro209@shiats.edu.in;*

## 1. INTRODUCTION

Pulses are valuable source of dietary protein and have a specific ability to sustain and preserve soil fertility by adding biological nitrogen fixation. Pulses are restoratives crops and leaves quite enough as 30 kg/ha nitrogen in soil (Reddy and Reddy, 2010). Chickpea (*Cicer arietinum L*.) is the fourth largest grain legume crop in the world, with a total production of 13.1 m t from an area of 13.5 m ha and productivity of 0.97 t/ha [1]. India is one of the important chickpea growing countries in Asia with an area of 9.6 m ha and production of 8.83 m t [1]. Among the pulses, chickpea is an important *rabi* season crop with high acceptability and wider use in nutritional food basket. It is a good source of carbohydrates and protein, and protein quality is considered to be better than other pulses. In India pulses are grown nearly in 28.83 m ha with an annual production of 25.72 m t and productivity of 0.8t ha.Some of the states like Uttarpradesh is about 8.24 m ha with an annual production of 9.97 m t and productivity of 1.08 t ha major producer of chickpea in India as advocated by Ministry of agriculture and Farmer Welfare [2]. Besides, it is also important for sustainable agriculture as it improves the physio-chemical and biological properties of the soil. Its deep roots also open the soil, whichensure better aeration and heavy leaf drop increases the organic matter in the soil. It can fix about 25-30 kg N/ ha through symbiosis and these minimize dependency on chemical fertilizers. Thus, chickpea plays a vital role in improving the soil health [3].

The role of bio-fertilizers is also well recognized which supplies macro and micro nutrients necessary for the plant growth. Bio-fertilizers also develops a sustainable agriculture system by maintaining soil fertility, soil physical properties, ecological balance and providing stability to the production without polluting soil, water and air. Among bio-fertilizers Rhizobium inoculation is cheapest, easiest and safest method of supplying nitrogen to legumes through well-known symbiotic nitrogen fixation process. It increases the yield and improves the quality of legumes, also adds substantial amount of residual nitrogen in soil for subsequent crops. Phosphate solubilizing bacteria (PSB) have the consistent capacity to increase the availability of phosphates to plants by mineralizing organic phosphorus compounds. It solubilizes insoluble inorganic phosphorus compounds by exerting organic acids, which is the primary mechanism of solubilizing of insoluble inorganic phosphates. Besides organic acids, production of chelating substances, mineral acids, siderophores and proton extrusion mechanism are also involved [4].

Sulphur is the fourth major nutrient next to N, P and K and an essential element for plant growth particularly for legumes crops which play an important role in plant metabolism system. Sulphur promotes nodulation in legumes and favors solubilization of organic nitrogen and decrease the quantity of insoluble nitrogen resulting in reduction of Sulphur. [5] observed that mean yields increased 8.2 and 4.8 per cent in case of grain and 4.5 and 3.4 per cent in case of straw with application of Sulphur.

## 2. MATERIALS AND METHODS

The experiment was carried out during *rabi* season of 2021-22 at Crop Research Farm, Department ofAgronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.). which is located at $25^0$ 30' 42''N latitude, $81^0$ 60' 56" E longitude, and a height of 98 metres above sea level. The soiltexture in the experimental plot was sandy loam, with a practically neutral soil (PH 7.1), low in organic carbon (0.36%) available N (171.48 kg/ha), available P (27.0 kg/ha) and K (291.2 kg/ha). The crop was sown on 19 November 2021 using variety NBeG-49. The experiment was set up in a Randomized Block Design with three replications and nine treatments in total *Viz.,* T1: Rhizobium at 25g/kg seeds + Sulphur at 15kg/ha, T2: Rhizobium at 25g/kg seeds + Sulphur at 20kg/ha, T3: Rhizobium at 25g/kg seeds + Sulphur at 25kg/ha, T4: PSB at 25g/kg seeds + Sulphur at 15kg/ha, T5: PSB at 25g/kg seeds + Sulphur at20kg/ha, T6: PSB at 25g/kg seeds + Sulphur at 25kg/ha, T7: Rhizobium(12.5g/kg seeds )+ PSB(12.5 g/kgseeds) + Sulphur ( 15kg/ha), T8: Rhizobium(12.5g/kg seeds )+ PSB(12.5 g/kg seeds) + Sulphur (20kg/ha) and T9: Rhizobium (12.5g/kg seeds )+PSB (12.5g/kg seeds)+Sulphur ( 25kg/ha). Recommended dose of fertilizers (N:P: K) will be supplied in the form of Urea, single super phosphate (SSP), and muriate of potash (MOP) as a basal dose in all plots, and the seed treatment with Biofertilizers was done prior to 24 hours of sowing and Sulphur will be applied according to the treatment levels. The growth Parameters were measured at harvest stage, from randomly selected plants in each treatment. The yield attributes were recorded at harvest form

randomly selected plants in each plot. The data was computed and analysed by following statistical method of Gomez and Gomez [6].

## 3. RESULTS AND DISCUSSION

### 3.1 Effect of Biofertilizers and Sulphur on Growth Attributes of Chickpea

#### 3.1.1 Plant height (cm)

At harvest, significantly higher plant height (59.3cm) was recorded in treatment-9 [Rhizobium (12.5g/kg seeds)+PSB(12.5g/kg seeds) +Sulphur (25kg/ha)]as compared to the rest of the treatments. However, the treatment-8 [Rhizobium(12.5g/kg seeds )+PSB(12.5 g/kg seeds) +Sulphur (20kg/ha)] was found to be statistically at par with treatment-9 [Rhizobium(12.5g/kg seeds )+PSB(12.5g/kg seeds) + Sulphur (25kg/ha)].Significant increase in plant height with Rhizobium and PSB might be due to increase in uptake of N and P by the plants,which might be due to more N-fixation and P-solubilisation through micro-organisms [7]. Further Sulphur plays a vital role in chlorophyll formation required for development of cells and constituent of a number of organic compounds [8].

#### 3.1.2 Number of nodules/plant

Significantly maximum number of nodules/ plant (7.8) was recorded with treatment- 9 [Rhizobium(12.5g/kg seeds )+PSB(12.5 g/kg seeds) + Sulphur (25kg/ha)] which was superior over all other treatments. However, the treatment-8 [Rhizobium(12.5g/kg seeds )+ PSB(12.5g/kg seeds) + Sulphur (20kg/ha)]was found to be statistically at par with treatment-9[Rhizobium(12.5g/kg seeds )+PSB(12.5g/kg seeds) + Sulphur (25kg/ha)].Significant and maximum number of nodules/plant was with application of Rhizobium, increase the number of nodules by availability of nitrogenase enzyme PSB facilitates the nodule formation by proper development of nodules by increasing availability of phosphorus through the mobilizing the unavailable phosphorus present in soil [7]. Further sulphur promotes nodulation in legumes and favours solubilization of organic nitrogen and decrease the quantity of insoluble nitrogen,Resulted in higher nodules formation which ultimately increase maximum number of nodules/plant. The results were similar to [8].

#### 3.1.3 Plant dry weight (g)

Significantly maximum Plant Dry weight (66.3 g) was recorded in treatment-9 [Rhizobium(12.5g/kg seeds )+ PSB(12.5 g/kgseeds) + Sulphur ( 25kg/ha)] which was superior over all other treatments.However, the treatment-8[Rhizobium(12.5g/kg seeds )+ PSB(12.5 g/kgseeds) + Sulphur (20kg/ha)] is statistically at par with treatment-9[Rhizobium(12.5g/kg seeds )+ PSB(12.5 g/kgseeds) + Sulphur (25kg/ha)]. Significant increase in plant dry weight with Dual inoculation of Rhizobium (12.5g/kg seed) and PSB (12.5g/kg seed) along with soilapplication of Sulphur at 25 kg/ha was found to be effective in increasing the Dry matter production from advanced growth stages to at harvest in which seed treatment with rhizobium had fixed atmospheric nitrogen in the soil into available forms and PSB increased availability of phosphates to plants by mineralizing organic phosphorus compounds. The results are in accordance with [7,9]. Further, increase in fresh and dry weight of nodules/ plant under sulphur application might be chiefly due to the improvement in soil properties and also sulphur application could be ascribed to its pivotal role in regulating the metabolic and enzymatic process including photosynthesis and respiration in plants. This might be due to certain of favourable soil ecological condition for growth and development of nitrogen fixing bacteria (Rhizobium spp.). Results were similar to [10].

### 3.2 Effect of Biofertilizers and Sulphur on Yield and Yield Attributes of Chickpea

#### 3.2.1 Number of pods/plant

Treatment-9 [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kgseeds) + Sulphur (25kg/ha)]was recorded significantly maximum number of pods per plant (67.6) which was superior over all other treatments. However, the treatment- 8 [Rhizobium(12.5g/kg seeds )+ PSB(12.5 g/kgseeds) + Sulphur(20kg/ha)] (66.9) was found to be statistically at par with the treatment-9[Rhizobium(12.5g/kg seeds )+PSB(12.5 g/kgseeds) + Sulphur (25kg/ha)]. Significant increase number of pods/plant this might be due to more availability of sulphur during these vegetative and reproductive stages of the crop. Sulphur is a part of amino acid (Cystine), which helps in chlorophyll formation, photosynthetic process and activation of enzymes. The result were similar to [11].

### 3.2.2 Number of seeds/ pod

Treatment-9 [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) + Sulphur (25kg/ha)] was recorded significantly maximum number of seeds per pod (2.8) which was superior over all other treatments.However, the treatment-8 [Rhizobium (12.5g/kg seeds)+ PSB(12.5 g/kg seeds) + Sulphur(20kg/ha)] (2.7) was found to be statistically at par with the treatment-9 [Rhizobium (12.5g/kg seeds) + PSB(12.5g/kg seeds) + Sulphur (25kg/ha)]. Significant increase in number of seeds/pod Probably may be due to balanced nutrition and proper vegetative growth which later converted into reproductive phase and resulted might in more number of seeds**.** The results were similar to [10].

### 3.2.3 Seed index (g)

Treatment-9 [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) +Sulphur (25kg/ha)] was recorded significantly maximum seed index (28.0) which was superior over all other treatments. However, the treatment-8 [Rhizobium (12.5g/kg seeds)+PSB(12.5g/kg seeds) +Sulphur (20kg/ha)] (27.6) was found to be statistically at par with the treatment-9 [Rhizobium(12.5g/kg seeds)+PSB(12.5g/kg seeds) +Sulphur (25kg/ha)].

### 3.2.4 Seed yield (kg/ha)

Treatment-9 [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) + Sulphur (25kg/ha)]was recorded significantly maximum Seed yield (1748.8 kg/ha) which was superior over all other treatments. However, the treatment-8[Rhizobium(12.5g/kg seeds) + PSB(12.5g/kg seeds) + Sulphur(20kg/ha)] was found to be statistically at par with the treatment-9[Rhizobium(12.5g/kg seeds)+PSB(12.5g/kg seeds) + Sulphur(25kg/ha)]. Significant increase in seed yield might be due to the Dual inoculation of Rhizobium can increase seed yield in pulse crop upto 10 to 15% while PSB increase availability of insoluble phosphorous into soil. Results were similar to [7]. Further role of sulphur in stimulation of cell division, photosynthetic process as well as formation of chlorophyll. It also promotes the root nodules in legumes, which cause the more sulphur available during vegetative growth period and development of plant occurs. It resulted in higher seed yield. The result were similar to [12].

**Table 1. Effect of Biofertilizers and Sulphur on growth and yield of Chickpea**

| S. No. | Treatments | Plant Height (cm) | Number of Nodules/plant | Plant Dry weight (g) |
|---|---|---|---|---|
| 1 | Rhizobium (25g/kg seeds)+ Sulphur (15kg/ha) | 54.8 | 3.7 | 57.5 |
| 2 | Rhizobium (25g/kg seeds)+ Sulphur (20kg/ha) | 57.2 | 5.5 | 65.9 |
| 3 | Rhizobium (25g/kg seeds)+ Sulphur (25kg/ha) | 58.1 | 6.0 | 64.3 |
| 4 | PSB (25g /kg seeds) +Sulphur (15kg/ha) | 55.4 | 4.3 | 59.4 |
| 5 | PSB (25g/kg seeds)+ Sulphur (20kg/ha) | 55.9 | 5.1 | 60.6 |
| 6 | PSB (25g/kg seeds)+ Sulphur (25kg/ha) | 56.6 | 5.3 | 63.2 |
| 7 | [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) +Sulphur (15kg/ha)] | 56.7 | 4.9 | 60.4 |
| 8 | [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) +Sulphur (20kg/ha)] | 58.7 | 7.6 | 66.2 |
| 9 | [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) +Sulphur (25kg/ha)] | 59.3 | 7.8 | 66.3 |
| | F test | S | S | S |
| | SEm (±) | 0.23 | 0.36 | 0.39 |
| | CD (P=0.05) | 0.69 | 1.07 | 1.17 |

**Table 2. Effect of Biofertilizers and Sulphur on yield attributes of chickpea.**

| S. No. | Treatments | No.of Pods/plant | No. of Seeds/pod | Seed Index (g) | Seed yield (kg/ha) | Stover yield (kg/ha) | Harvest index (%) |
|---|---|---|---|---|---|---|---|
| 1 | Rhizobium (25g/kg seeds)+ Sulphur (15kg/ha) | 56.1 | 2.2 | 26.2 | 1058.3 | 2288.8 | 31.0 |
| 2 | Rhizobium (25g/kg seeds)+ Sulphur (20kg/ha) | 64.2 | 2.6 | 27.0 | 1504.9 | 2699.2 | 35.6 |
| 3 | Rhizobium (25g/kg seeds)+ Sulphur (25kg/ha) | 65.9 | 2.7 | 27.1 | 1662.9 | 2785.7 | 37.2 |
| 4 | PSB (25g/kg seeds)+ Sulphur (15kg/ha) | 59.1 | 2.2 | 26.7 | 1133.9 | 2404.5 | 31.1 |
| 5 | PSB (25g/kg seeds)+ Sulphur (20kg/ha) | 61.6 | 2.5 | 27.2 | 1375.5 | 2493.6 | 34.0 |
| 6 | PSB (25g/kg seeds)+ Sulphur (25kg/ha) | 61.7 | 2.5 | 27.4 | 1411.8 | 2557.9 | 34.1 |
| 7 | [Rhizobium(12.5g/kg seeds)+PSB(12.5g/kg seeds) +Sulphur (15kg/ha)] | 59.2 | 2.3 | 26.8 | 1211.3 | 2355.4 | 32.8 |
| 8 | [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) +Sulphur (20kg/ha)] | 66.9 | 2.7 | 27.6 | 1662.4 | 2867.8 | 36.0 |
| 9 | [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) +Sulphur (25kg/ha)] | 67.6 | 2.8 | 28.0 | 1748.8 | 2957.8 | 36.5 |
| | F test | S | S | S | S | S | S |
| | SEm (±) | 0.62 | 0.04 | 0.20 | 21.09 | 26.53 | 0.59 |
| | CD (P=0.05) | 1.86 | 0.12 | 0.61 | 63.22 | 79.55 | 1.78 |

### 3.2.5 Stover yield (kg/ha)

Treatment-9 [Rhizobium(12.5g/kg seeds)+ PSB(12.5g/kg seeds) +Sulphur (25kg/ha)] was recorded significantly maximum Stover yield (2957.8 kg/ha) which was superior over all other treatments.However,the treatment-8 [Rhizobium (12.5g/kg seeds)+PSB(12.5g/kg seeds) +Sulphur (20kg/ha)] was found to be stastically at par with treatment- 9[Rhizobium(12.5g/kg seeds) + PSB (12.5g/kg seeds) +Sulphur (25kg/ha)] . Significant increase in stover yield with Dual inoculation of Rhizobium,PSB increase in nitrogen availability in soil leads to increase in content of nitrogen in seed and increase in P availability through solubilization of insoluble native P and production of plant growth promoting substances.Results were similar to [13] (Singh et al., 2014).

### 3.2.6 Harvest index (%)

Treatment-3[Rhizobium (25g/kg seeds) + Sulphur (25kg/ha)] was recorded significantly maximum harvest index (37.2%) which was superior over all other treatments.However the ,treatment-8 [Rhizobium (12.5g/kg seeds)+ PSB (12.5g/kg seeds) + Sulphur (20kg/ha)] (36.0%) and treatment-9 [Rhizobium(12.5g/kg seeds)+ PSB (12.5g/kg seeds) + Sulphur (25kg/ha)] (36.5%) was found to be stastically at par with the treatment- 3[Rhizobium (25 g/kg seeds) + Sulphur (25kg/ha)].

## 4. CONCLUSION

From the present study it can be concluded that for better crop growth and productivity of Chickpea,seeds should be inoculated with Rhizobium (12.5g/kg seeds) , PSB (12.5g/kg seeds) and soil application Sulphur at 25kg/ha along with recommended dose of fertilizers recorded highest growth and yield parameter, which may be more preferable for farmers.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES


1. Faostat; 2013.
   Available:http://faostat.fao.org/default.aspx
   Accessed on September, 2020.
2. GOI. Economics and statistics of Indian agriculture. Annual report, Government of India, New Delhi; 2020-21.
3. DES, Ministryof Agriculture & FW. Success report of 2018-2019, pulses Revolution – From food to nutritional security; 2018.
   Available:https://farmers.gov.in/SucessReport 2018-19 and retrieved on July 17, 2020.
4. Gaur AC. Phosphate solublizing microorganism as biofertilizers. Omega Scientific Publishers, New Delhi. 1990;188.
5. Singh SK, Chauhan SPS. Effect of sulphur and phosphorus fertilization on yield attributes and yield of cluster bean varieties under dry land conditions; 2015.
6. Gomez KA, Gomez AA. Statistical procedures for agricultural research (2 ed.). John Wiley and Sons, New York. 1984;680.
7. Singh R, Pratap T, Singh D, Singh G, Singh AK. Effect of phosphorus. Sulphur and biofertilizers on growth attributes and yield of chickpea (*Cicer arietinum* L.). Journal of Pharmacognosy and phytochemistry. 2018;7(2):3871-3875.
8. Das SK, Biswas B, Jana K.. Effect of farm yard manure, phosphorus and sulphur on yield parameters, yield parameters, yield, nodulation, nutrient uptake and quality of chickpea (*Cicer arietinum* L.). Journal of Applied and Natural Science. 2016; 8(2):545-549.
9. Pramanik K, Bera AK. Response of biofertilizer and phytohormone on growth and yield of chickpea (*Cicer arietinum* L.). Journal of crop and weed. 2012;8(2):45-49.
10. Ram S, Katiyar TPS. Response of sulphur and zinc on yield, quality and nutrient uptake of summer mungbean (*Vigna radiat*a L. Wilczek); 2018.
11. Mitra AK, Banerjee K, Pal AK. Effect of different levels of phosphorus and sulphur on yield attributes, seed yield, protein content of seed and economics of summer green gram.Res. Crops. 2006;7(2):404-405.
12. Kadam SS, Patil AV, Mahadkar UV, Gaikwad CB. Effect of potassium and sulphur on the growth and yield of summer green gram. J. Maharashtra agric. Univ. 2006;31(3):382-383.

13. Chauhan SVS, Raghav BS. Effect of phosphorus and phosphate solubilizing bacteria on growth, yield and quality of chickpea (*Cicer arietinum*). Annals of Plant and Soil Research. 2017;19(3), 303-306.



*Peer-review history:*
*The peer review history for this paper can be accessed here:*
*https://www.sdiarticle5.com/review-history/89960*