



# Impact of Different Sources of Phosphorus and Sulphur Levels on Growth, Yield Attributes and Performance of Chickpea under Light Textured Soil

Anuradha Yadav <sup>a++\*</sup>, Amit Kumawat <sup>b#</sup>,  
Pooja Kumari Meena <sup>ct</sup>, Suwa Lal Yadav <sup>d#</sup>,  
Deepika Yadav <sup>a++</sup>, Sampat Choudhary <sup>ct</sup>  
and Anju Kanwar Khangarot <sup>e#</sup>

<sup>a</sup> Department of Agronomy, Sri Karan Narendra Agriculture University, Jobner, Rajasthan-303329, India.

<sup>b</sup> Swami Keshwanand Rajasthan Agriculture University, Bikaner-334006, India.

<sup>c</sup> Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur-313001, India.

<sup>d</sup> School of Agricultural Sciences, Raffles University, Neemrana-301705, India.

<sup>e</sup> Department of Agronomy, Rajasthan Agriculture Research Institute, Durgapura, Jaipur-302018, India.

## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

## Article Information

DOI: <https://doi.org/10.9734/jeai/2024/v46i62511>

### 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/116821>

<sup>++</sup> Ph.D. Research Scholar;

<sup>#</sup> Assistant Professor;

<sup>†</sup> Ph.D. Scholar;

\*Corresponding author: E-mail: [anuradhyadav21199@gmail.com](mailto:anuradhyadav21199@gmail.com);

**Cite as:** Yadav, A., Kumawat, A., Meena, P. K., Yadav, S. Lal, Yadav, D., Choudhary, S., & Khangarot, A. K. (2024). Impact of Different Sources of Phosphorus and Sulphur Levels on Growth, Yield Attributes and Performance of Chickpea under Light Textured Soil. *Journal of Experimental Agriculture International*, 46(6), 575–582. <https://doi.org/10.9734/jeai/2024/v46i62511>

## ABSTRACT

**Background:** Pulses are most important source of dietary protein, belonging to the family of *Leguminosae* and strictly harvested for their dried seeds. Phosphorus and sulphur nutrients play a vital role in quality production and nutritional values. Phosphorus rich organic manure (PROM) have potential to release organic acids to enhance native soil phosphorus mineralization.

**Methods:** This investigation was carried out at Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agriculture University, Bikaner during *Rabi* season of 2021-22 with the use of different levels of phosphorus and sulphur to investigate the growth rate, yield parameters and performances of chickpea. The experiment was laid out in factorial randomized block design comprising three phosphorus sources with a certain amount of 32 kg P ha<sup>-1</sup> through di ammonium phosphate (DAP), single super phosphate (SSP) and PROM and four sulphur levels (control, 20, 40 and 60 kg ha<sup>-1</sup>) and it was replicated thrice.

**Results:** The application of 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through PROM significantly increase higher growth parameters, yield attributes and yield in comparison to 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through DAP and SSP. Among sulphur levels, upto 40 kg S ha<sup>-1</sup> showed significantly higher growth rate and yield characters. The PROM can be a better strategy for the improvement of growth and yield characters.

*Keywords:* Nutritional values; phosphorus rich organic matter; quality; and soil fertility.

## 1. INTRODUCTION:

Nowadays farmers are using excess amount of chemical fertilizers for the crop production. However, excess use of chemicals and fertilizers is the main cause of soil deterioration and poor product quality. Therefore, the present investigation was carried with different sources of phosphorus through organic and inorganic sources along with different levels of sulphur to knowing their effects in crop production for better quality and nutritional values. Pulses are a significant source of protein in the diet and possess unique qualities that boost the biological value of protein and restore soil fertility. Chickpea (*Cicer arietinum* L.) plays a vital role in pulse production as well as in consumption by Indians and originated in south eastern turkey and derived from the greek word 'kikus' meaning force or strength. Chickpea is mostly consumed in the form of processed whole seed and *dal* but also used for preparing a variety of snacks, sweets and condiments which are very useful for stomach ailments and blood purification [1]. India holds the record for both chickpea production and acreage worldwide. It has 18–22% protein, 52–70% carbohydrates, 4–10% fat and adequate amounts of calcium, phosphorus, iron and vitamins. Additionally, it is critical for sustainable agriculture since it enhances the biological and

physico-chemical characteristics of the soil. Its deep roots also allow the soil to open up, improving aeration and raising the amount of organic matter in the soil due to high leaf fall [2].

Crop growth and development are primarily dependent on the development of root system. Phosphorus is one of the main macro-nutrient that has significant roles in root formation, growth, flowering and ripening. Improved root growth in pulses facilitates improved *Rhizobium* bacterial nodulation. A sufficient amount of phosphorus causes the plant to mature more quickly and speeds up the development of pods and nodulation [3].

Sulphur is one of essential nutrient element require for growth and metabolism, however, fertilizer recommendations do not adequately account for this important nutrient. It is an essential component of higher pulse production and is important for the synthesis of enzymes, vitamins and proteins in plants. Because nitrogen is fixed by symbiosis with *Rhizobium* bacteria, the study of phosphorus and sulphur to legumes is therefore more important than that of nitrogen [4]. Consequently, this experiment was conducted using different phosphorus sources and sulphur levels.

## 2. MATERIALS AND METHODS

### 2.1 Experimental Site

The experiment was conducted at the Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *Rabi*, 2021. The plot size was 4.2 m x 4.0 m with total 604.8 m<sup>2</sup>, under loamy sand soil which was slightly alkaline in reaction, poor in organic carbon (0.09), low in available nitrogen (115.4 kg ha<sup>-1</sup>), phosphorus (14.5 kg ha<sup>-1</sup>) and sulphur (7.3 kg ha<sup>-1</sup>) but medium in available potassium (212.35 kg ha<sup>-1</sup>). The GNG-1581 cultivar was used for sowing with 80 kg/ha at 30 x 10 cm of crop geometry.

### 2.2 Treatment Details

This experiment was laid out in factorial randomized block design with 12 treatment combinations replicated thrice. The treatment details were given as:

**List 1. Treatment details**

| Treatments code                                  | Details |
|--|---------|
| <b>Phosphorus source (32 kg ha<sup>-1</sup>)</b> |         |
| P <sub>1</sub>                                   | DAP     |
| P <sub>2</sub>                                   | SSP     |
| P <sub>3</sub>                                   | PROM    |
| <b>Sulphur levels (kg ha<sup>-1</sup>)</b>       |         |
| S <sub>0</sub>                                   | Control |
| S <sub>1</sub>                                   | 20      |
| S <sub>2</sub>                                   | 40      |
| S <sub>3</sub>                                   | 60      |

### 2.3 Source and Mode of Application

Phosphorus was applied through DAP, SSP and PROM and sulphur was applied through Gypsum as per the treatment as a basal application.

### 2.4 Methods used for Observation used

**Crop growth rate (CGR):** Crop growth rate was computed between 30-60 DAS, 60-90 DAS and 90 DAS -harvest. Using the dry weight measured at various intervals, the crop growth rate was computed. It indicates the overall growth rate of crop and is measured after a set amount of time, regardless of the previous growth rate. The value was calculated by using the formula suggested by Hunt [5]:

$$CGR (g m^{-2} day^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where,

$W_2 - W_1$  = Difference in oven dry biomass at the time interval

$t_2 - t_1$  = Time interval in days

**Relative growth rate (RGR):** This parameter indicates rate of growth per unit dry matter. It was computed by using formula as suggested by Radford [6]:

$$RGR (g g^{-1} day^{-1}) = \frac{\ln W_2 - \ln W_1}{t_2 - t_1}$$

Where,

$\ln W_2 - \ln W_1$  = Natural logarithm of dry matter at time  $t_2$  and  $t_1$ , respectively

**Pods plant<sup>-1</sup>:** The pods were counted manually from five randomly selected plants at the time of harvest and average was calculated for the results.

**Seeds pod<sup>-1</sup>:** At the time of harvesting, number of pods was counted from randomly selected from each plot and their total seeds were averaged to record the number of seeds pod<sup>-1</sup>.

**Test weight:** The test weight was calculated based on counting of thousand seeds randomly by taking handful of samples and weighed on electronic balance.

**Seed, straw and biological yield:** Each net plot's total biomass was threshed, winnowed, cleaned and dried. The resulting grains, straw or haulm were weighed in kilograms net plot<sup>-1</sup> before being converted to kilograms ha<sup>-1</sup>. The sum of seed and straw yield was biological yield.

**Harvest index:** It was computed by using the formula given by Donald [7].

$$\text{Harvestindex (\%)} = \frac{\text{Economical yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}}$$

### 2.5 Statistical Analysis

The methodology described by Panse and Sukhatme [8] was followed to statistically analyze the data collected in order to determine the significance of variance at 5% level of significance. The "F" test was determined to be significant at the five percent and one percent

levels of significance after the crucial differences were computed to evaluate the significance of treatment means.

### 3. RESULTS AND DISCUSSION

The Growth rate, yield attributes and yield were significantly influenced by different sources of phosphorus and levels of sulphur throughout the growth period and at harvest.

#### 3.1 Crop Growth Rate (CGR)

**Effect of source of phosphorus:** The Fig. 1 shows that maximum crop growth rate was recorded by the application of 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through PROM and significantly superior over application of phosphorus through DAP and SSP with the tune of 16.01, 8.17% at 30-60 DAS and 30.09, 12.96% at 60-90 DAS and 40.55, 16.98% at harvest, respectively.

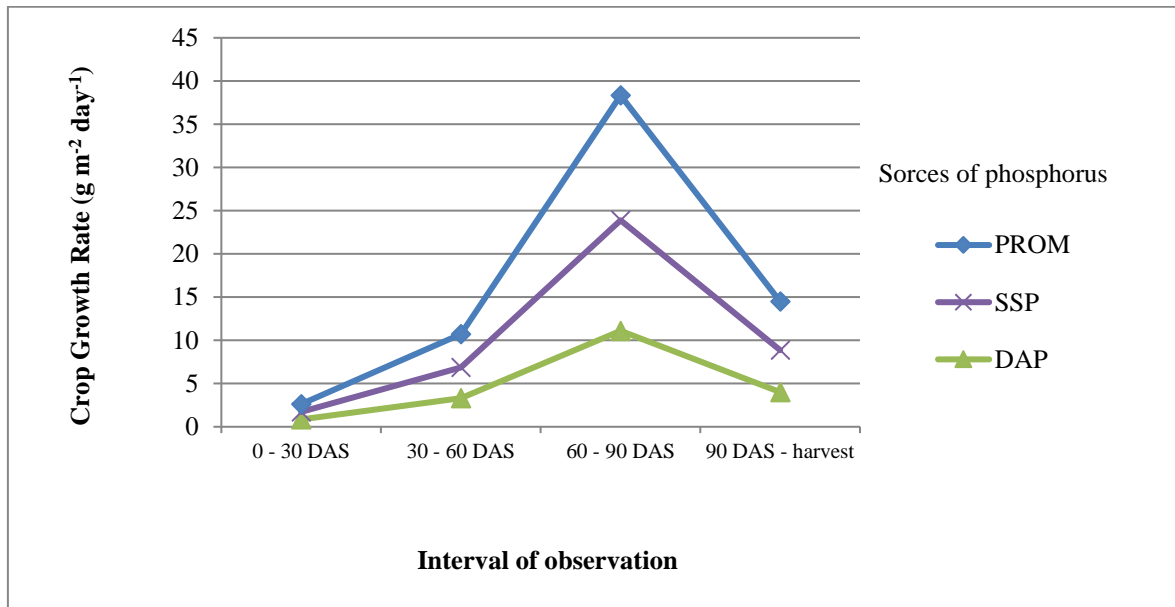


Fig. 1. Crop growth rate as influenced by different sources of phosphorus

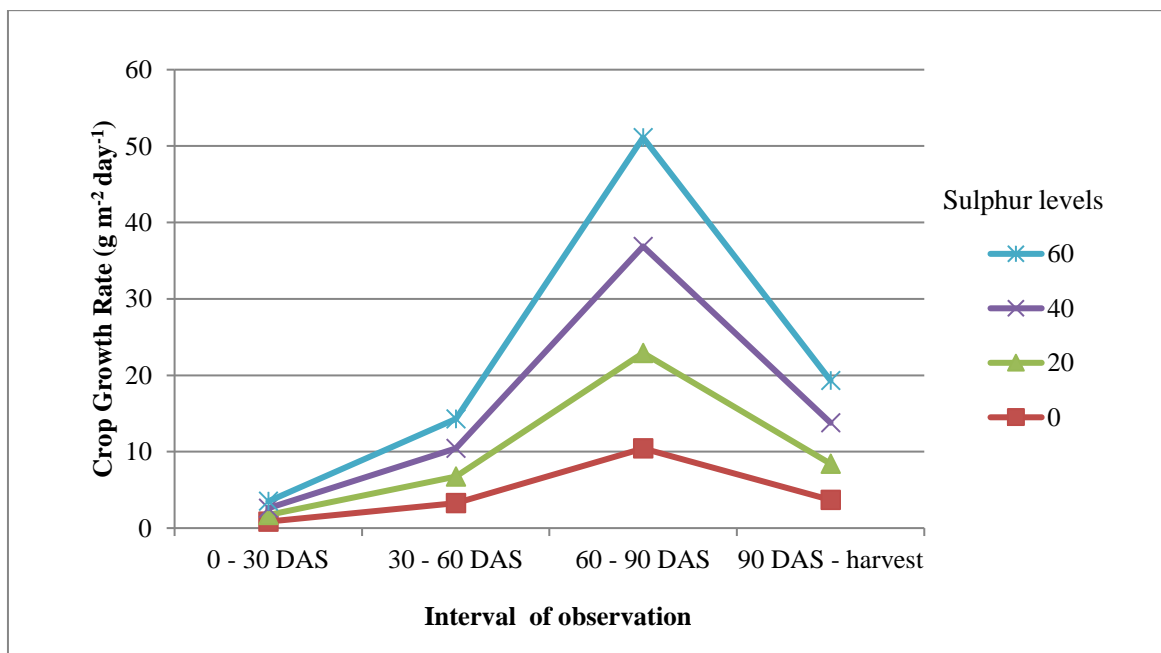


Fig. 2. Crop growth rate as influenced by different levels of sulphur

**Effect of levels of sulphur:** Sulphur application had significant effect on crop growth rate at 30-60 DAS, 60-90 DAS and at harvest (Fig. 2). Application of 40 kg S ha<sup>-1</sup> significantly increased the crop growth rate compare to control and 20 kg S ha<sup>-1</sup> by 13.14, 6.32% at 30-60 DAS and 33.87, 11.60% at 60-90 DAS and 45.67, 14.43 at harvest, respectively.

### 3.2 Relative Growth Rate

**Effect of sources of phosphorus:** The results depicted in Fig.3, showed that phosphorus sources significantly influenced the relative growth rate at 30-60 DAS, 60-90 DAS and at harvest. Among the sources, application of 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through PROM significantly increased relative growth rate over 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through DAP and SSP with the magnitude of 4.78, 2.25% at 30-60 DAS and 7.60, 2.61% at 60-90 DAS and 10.41, 4.13% at harvest, respectively.

These findings could be the consequence of increased sulphur availability, which raised photosynthetic activity and plant metabolism and thus led to improved growth. It is also evident from the fact that applying sulphur has been shown to increase the availability of sulphur and other nutrients, all of which are thought to be crucial for the growth and development of plants. The current study's results are consistent with those of Prajapat et al. [9] and Kumawat et al. [10].

**Effect of levels of sulphur:** Fig. 4 illustrates that significantly higher relative growth rate was

recorded by the application of 40 kg S ha<sup>-1</sup> which was superior over control and 20 kg S ha<sup>-1</sup> by 4.07, 2.21% at 30-60 DAS and 11.00, 3.38% at 60-90 DAS and 12.69, 3.63% at harvest, respectively.

Addition of PROM enhances the activity and population of *Rhizobium* bacteria in roots and thus increased the availability of nitrogen for plant growth. Similar result was found with Bairwa et al. [11] who observed the dry matter accumulation increased significantly with the application of PROM as a source of phosphorus which also indicate growth rate.

### 3.3 Pods Plant<sup>-1</sup>

**Effect of sources of phosphorus:** The information in Table 1, shows that higher pods plant<sup>-1</sup> were recorded by the application of PROM as a source of phosphorus and it was significantly superior over DAP and SSP. Applying 32 kg of P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> using PROM resulted in 13.76 and 7.51% more pods plant<sup>-1</sup> than applying 32 kg of P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through DAP and SSP, respectively.

**Effect of levels of sulphur:** Significantly increase in number of pods plant<sup>-1</sup> was recorded by the application of 40 kg S ha<sup>-1</sup> over control and 20 kg S ha<sup>-1</sup> which was statistically at par with 60 kg S ha<sup>-1</sup>, according to data reported in Table 1. The% increase in number of pods plant<sup>-1</sup> due to 40 kg S ha<sup>-1</sup> over control and 20 kg S ha<sup>-1</sup> was 7.20 and 20.19%, respectively.

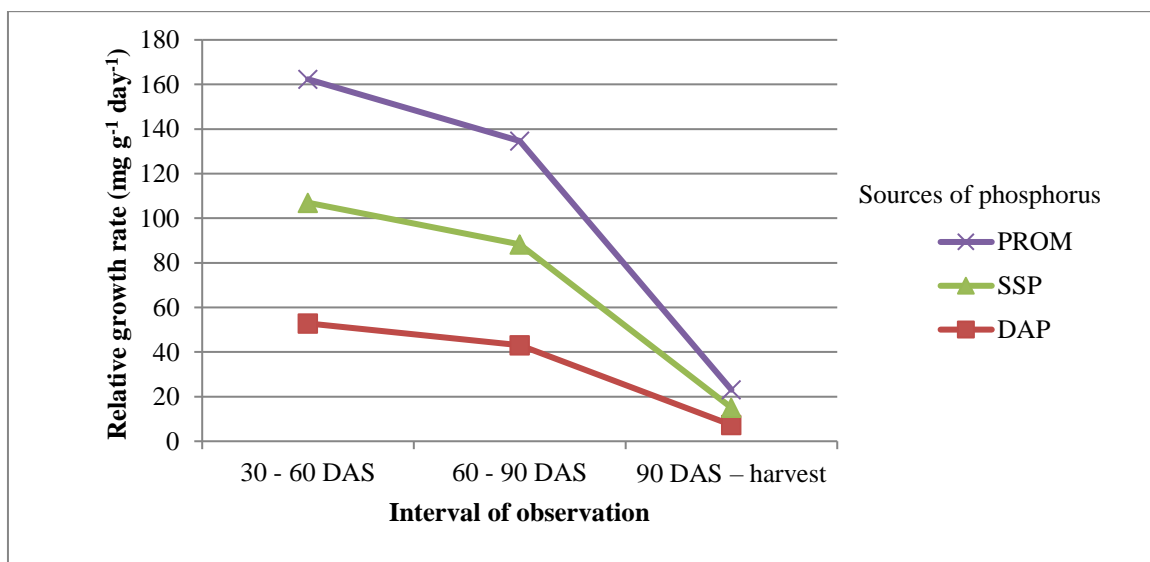


Fig. 3. Relative growth rate as influenced by different sources of phosphorus

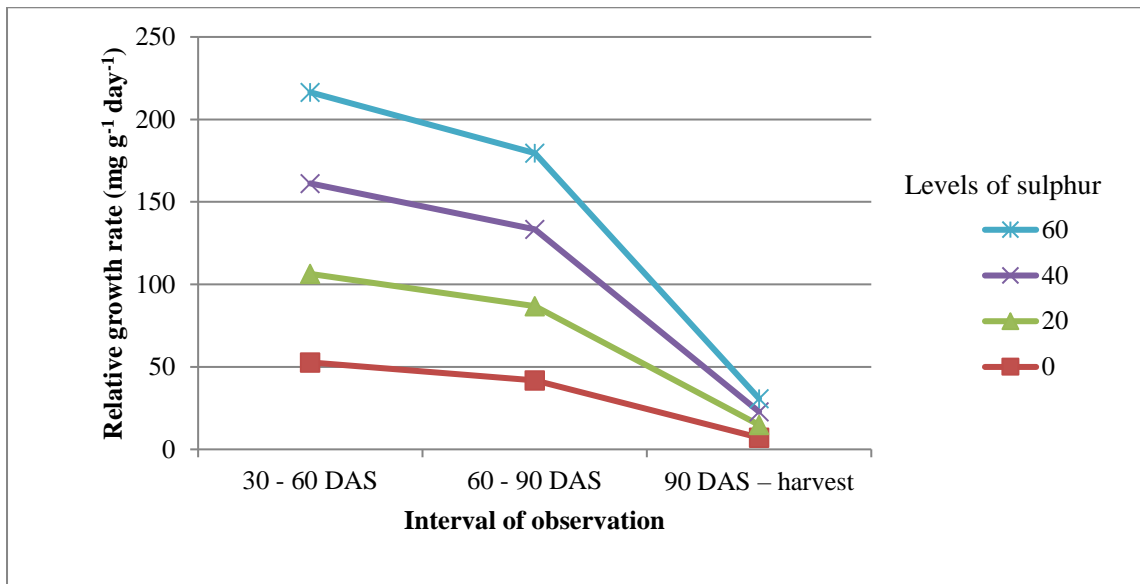


Fig. 4. Relative growth rate as influenced by different levels of sulphur

**Seeds pod<sup>-1</sup>:** Data presented in Table 1 revealed that number of seeds pod<sup>-1</sup> of chickpea did not influenced due to different sources of phosphorus and levels of sulphur.

### 3.4 Test Weight

**Effect of sources of phosphorus:** Test weight was significantly impacted by the application of various phosphorus sources, as evidenced by the data in Table 1. The test weight was considerably raised by 6.43 and 2.27%, respectively, when 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through PROM was applied as opposed to 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through DAP and 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through SSP.

**Effect of levels of sulphur:** Application of 40 kg S ha<sup>-1</sup> recorded a considerable increase in test weight and it was significantly superior over control and 20 kg S ha<sup>-1</sup>, but remained at par with 60 kg S ha<sup>-1</sup>. The% increase in test weight due to 40 kg S ha<sup>-1</sup> over control and 20 kg S ha<sup>-1</sup> with the magnitude of 11.11 and 5.53%, respectively.

### 3.5 Seed Yield

**Effect of sources of phosphorus:** Data presented in Table 2 showed that application of different sources of phosphorus had significant effect on seed yield of chickpea. Significantly higher seed yield was recorded by the application of 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through PROM over 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through DAP and SSP by 27.23 and 14.73%, respectively.

**Effect of levels of sulphur:** Data presented in Table 2 revealed that 40 kg S ha<sup>-1</sup> found significant enhancement in seed yield of chickpea over control and 20 kg S ha<sup>-1</sup> but it remains statistically at par with 60 kg S ha<sup>-1</sup>. The% increase due to 40 kg S ha<sup>-1</sup> was 33.34 and 12.99% over control and 20 kg S ha<sup>-1</sup>, respectively.

### 3.6 Straw Yield

**Effect of sources of phosphorus:** The information in Table 2 demonstrated that application of 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through PROM resulted in a considerable increase in straw yield compared to 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through DAP and SSP with the magnitude of 18.52 and 11.29%, respectively.

**Effect of levels of sulphur:** Maximum straw yield was obtained by the application of 40 kg S ha<sup>-1</sup> over control and 20 kg S ha<sup>-1</sup> by 28.87 and 8.62%, respectively. However, it was still comparable to 60 kg S ha<sup>-1</sup> (Table 2).

### 3.7 Biological Yield

**Effect of sources of phosphorus:** A thorough examination of the information in Table 2 showed that the application of various phosphorus sources significantly affected the biological yield of chickpeas. Maximum biological yield was recorded by the application of 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through PROM and it was significantly superior over 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through DAP and SSP, by 21.62 and 12.52%, respectively.

**Table 1. Effect of different sources of phosphorus and levels of sulphur on yield attributes of chickpea**

| Treatments   | Pods plant <sup>-1</sup> | Seeds pod <sup>-1</sup> | Test weight (g) |
|--|--------------------------|-------------------------|-----------------|
| <b>Sources of phosphorus (32 kg ha<sup>-1</sup>)</b> |                          |                         |                 |
| DAP  | 32.19                    | 1.63                    | 146.75          |
| SSP  | 34.06                    | 1.66                    | 152.72          |
| PROM   | 36.62                    | 1.72                    | 156.18          |
| SEm±   | 0.71                     | 0.03                    | 2.37            |
| CD (p = 0.05%)                                       | 2.09                     | NS                      | 6.95            |
| <b>Levels of sulphur (kg ha<sup>-1</sup>)</b>        |                          |                         |                 |
| 0  | 30.21                    | 1.64                    | 141.68          |
| 20   | 33.87                    | 1.67                    | 149.17          |
| 40   | 36.31                    | 1.69                    | 157.43          |
| 60   | 36.77                    | 1.70                    | 159.26          |
| SEm±   | 0.82                     | 0.04                    | 2.73            |
| CD (p = 0.05%)                                       | 2.41                     | NS                      | 8.02            |

**Table 2. Effect of different sources of phosphorus and levels of sulphur on yields and harvest index of chickpea**

| Treatments   | Yields (kg ha <sup>-1</sup> ) |       |            | Harvest index (%) |
|--|-------------------------------|-------|------------|-------------------|
|  | Seed                          | Straw | Biological |                   |
| <b>Sources of phosphorus (32 kg ha<sup>-1</sup>)</b> |                               |       |            |                   |
| DAP  | 1744                          | 3168  | 4912       | 35.63             |
| SSP  | 1934                          | 3374  | 5309       | 36.34             |
| PROM   | 2219                          | 3755  | 5974       | 37.08             |
| SEm±   | 48                            | 79    | 107        | 0.66              |
| CD (p = 0.05%)                                       | 142                           | 231   | 315        | NS                |
| <b>Levels of sulphur (kg ha<sup>-1</sup>)</b>        |                               |       |            |                   |
| 0  | 1606                          | 2864  | 4470       | 36.00             |
| 20   | 1901                          | 3398  | 5299       | 35.97             |
| 40   | 2148                          | 3691  | 5840       | 36.69             |
| 60   | 2208                          | 3777  | 5985       | 36.73             |
| SEm±   | 56                            | 91    | 124        | 0.77              |
| CD (p = 0.05%)                                       | 164                           | 267   | 364        | NS                |

This increase in yield and yield attributes by PROM may be due to an organic source of nutrition which contains organic matter and several essential nutrients with phosphorus and provide food for beneficial microorganism in field. Similar results were found with Yadav et al. [12] and Bairwa et al. [11].

**Effect of levels of sulphur:** Significantly higher biological yield was obtained by the application of 40 kg S ha<sup>-1</sup> which was statistically at par with 60 kg S ha<sup>-1</sup> and significantly superior over control and 20 kg S ha<sup>-1</sup> with the tune of 30.64 and 10.20%, respectively.

Overall yield attributes appear to have improved as a result of a balanced nutritional environment, effective and increased metabolite partitioning and sufficient nutrient translocation towards the development of reproductive structures or sinks.

In order to improve plant growth and development, sulphur improves root growth, encourages nodule formation and stimulates seed formation. These actions may have increased chickpea yield. Similar findings were also reported by Baviskar et al. [13], Yadav et al. [14].

### 3.8 Harvest Index (%)

Results showed that harvest index of chickpea remained unaffected due to different sources of phosphorus and levels of sulphur.

## 4. CONCLUSION

The application of 32 kg P<sub>2</sub>O<sub>5</sub> ha<sup>-1</sup> through phosphorus rich organic manure significantly increase the crop growth rate, relative growth rate, yield attributes like seeds pods<sup>-1</sup>, pods

plant<sup>1</sup>, seed, straw and biological yield. Among the sulphur levels application of 40 kg S ha<sup>-1</sup> significantly increased the crop growth rate, relative growth rate, yield attributes, seed, straw and biological yield.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

## REFERENCES

1. Singh R, Singh D, Pratap T, Singh AK, Singh H, Dubey S. Effect of different levels of phosphorus, sulphur and biofertilizers inoculation on nutrient content and uptake of chickpea (*Cicer arietinum* L.). International Journal Chemical Studies. 2018;6:2574-2579.
2. Grasso N, Lynch NL, Arendt EK, O'Mahony JA. Chickpea protein ingredients: A review of composition, functionality, and applications. Comprehensive reviews in food science and food safety. 2022;21(1):435-452.
3. Abbas S, Javed MT, Ali Q, Azeem M, Ali S. Nutrient deficiency stress and relation with plant growth and development. In engineering tolerance in crop plants against abiotic stress (pp. 239-262). CRC Press; 2021.
4. Jamal A, Moon YS, Zainul Abidin M. Sulphur-a general overview and interaction with nitrogen. Australian Journal of Crop Science. 2010;4(7):523-529.
5. Hunt. Plant growth analysis. Edward Arnold Publishing Limited, London. 1978;8-39.
6. Radford PJ. Growth analysis formulae-their use abuse 1. Crop Science. 1967;7(3):171-175.
7. Donald CM. In search of yield. The Journal of the Australian Institute of Agricultural Science. 1962;28:171-178.
8. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. Indian Council of Agricultural Research, New Delhi; 1985.
9. Prajapat K, Shivran AC, Yadav LR, Choudhary GL. Growth, production potential and economics of mungbean as influenced by intercropping systems and sulphur levels. Journal of Food Legumes. 2011;24(4):330-331.
10. Kumawat SR, Khistriya MK, Yadav SL, Kumar M. Effect of sulphur and phosphorus on growth and yield attributes on summer green gram [*Vigna radiata* (L.) Wilczek]. International Journal of Agricultural Science. 2014;10(2):770-773.
11. Bairwa PC, Sammauria R, Gupta KC. Direct and residual effect of PROM on productivity, nutrient uptake, soil properties and economics under clusterbean-wheat cropping system. Journal of Soil Salinity and Water Quality. 2019;11(1):84-89.
12. Yadav KR, Manohar RS, Kumawat SR, Yadav VK. Effect of phosphorus sources and phosphorus solubilizing microorganism on growth and yield of mungbean [*Vigna radiata* (L.) wilczek]. Chemical Science Review and Letters. 2017;6(22):1152-1155.
13. Baviskar VS, Shete PG, Daspute RA. Influence of organic fertilizers and sulphur levels on yield, quality and economics of cluster bean (*Cyamopsis tetragonoloba* L. Taub.). Asian Journal of Soil Science. 2010;5(1):94-96.
14. Yadav SL, Patel KC, Kumar D, Birla D, Makwana SN, Yadav IR, Yadav M, Lakshman Inwati DK, Gulaiya S. Impact of sulphur nanoparticles on growth and biological yield of groundnut-mustard crop sequence under sandy loam soils of central Gujarat. International Journal of Plant & Soil Science. 2023;35(20):1105-1112.  
Available: <https://doi.org/10.9734/ijpss/2023/v35i20390>

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

### Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/116821>