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Effect of Sulphur and Vermicompost on Growth Parameters, Yield Attributes and Yield of Chickpea

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Authors' contributions

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

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ABSTRACT

A field experiment was conducted during *Rabi* season of 2022-2023 at Rajoula Agriculture farm, of Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.). The present experiment having 4 levels of sulphur and 3 levels of vermicompost of 9 treatment combination replicated thrice in factorial randomized block design. Chickpea variety GNG-1958 (Marudhar)" was grown with recommended agronomic practices. On the basis of the results emanated from present investigation, it could be concluded that application of graded dose of sulphur significantly increases growth parameters (plant height, number of branches and number of nodule plant^{-1}), yield attributes (number of pod plant^{-1}, number of seed plant^{-1} and seed index) and seed yield. All the growth and yield parameters were significantly higher S @ 25 kg ha^{-1} as compared to S @ 20 kg ha^{-1} and S @15 kg ha^{-1}. Similarly different levels of vermicompost significantly increases growth

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parameters (plant height, number of branches and number of nodule plant^{-1}), yield attributes (number of pod plant^{-1}, number of seed plant^{-1} and seed index) and seed yield. However, it is clear from the information you've provided that the treatment with V @ 5 t ha^{-1} had a positive and statistically significant impact on the growth and yield parameters of the crop, and when combined with S @ 25 kg ha^{-1}, it produced the best results among the treatments tested.

Keywords: Chickpea; growth parameters; vermicompost and yield.

1. INTRODUCTION

"Pulses play a pivotal role and occupy a unique position in Indian agriculture by virtue of their inherent capacity to grow on marginal lands. It is an easily available source of protein in the rural heart of India. Pulses provide significant nutritional and health benefits and are known to reduce several non- communicable diseases such as colon cancer and cardio-vascular diseases" [1]. "India is the largest producer and consumer of pulses in the world. Major pulses grown in India include chickpea, pigeon pea, lentil, urd bean, mung bean, pea, lablab bean, moth bean, horse bean. It provide protein rich diet to the vegetarian of the Indian and complement the stable cereals in the diets with proteins, essential amino acids, vitamins and minerals" [2].

In India pulses are grown in 30.37 Mha of area with an annual production of 26.96 MT and productivity 888 kg ha^{-1} and Gram production 136.13 lakh tonnes (record) (According to PIB 2023). In M.P. pulses are grown in 21.60 lakh ha of area with an annual production of 32.14 lakh tons and productivity 1488.0 kg ha^{-1} (Ministry of Agri. & FW 2021).

They contain 22- 24% protein, which is almost twice the protein in wheat & thrice that of rice [3] and carbohydrate (61.51%), fat (4.5%) and relatively free from anti nutritional factors [4]. "Chickpea is rich in protein content (20.47 g/100 g), carbohydrate (62.95 g/100 g), fibre (12.2 g/100 g), phosphorous (252 mg/l00 g), high amount of minerals such as calcium (57 mg/100 g), magnesium (79 mg/100 g), iron (4.31 mg/l00 g) and zinc (15 mg/100 g), low in fat content and most of it is polyunsaturated" [5]. "It is originated in south eastern turkey" [6]. "Chickpea as a legume crop plays a significant role in improving soil fertility by fixing the atmospheric nitrogen" [7].

"Sulphur is a secondary nutrient and plays a vital role in plant metabolism as the main constituent of the sulphur containing amino acids (methionine and cysteine), Vitamin C (Glutathione, biotine and thiamine), lipoic acid and acetyl CO-A. In addition to these functions, ferro-sulphur proteins play an important role in nitrogen fixation and electron movement in photosynthesis" [8]. "Sulphur has positive effect on root growth in plants and this elements also help in the nodule formation in legumes crops. It is also associated with the aromatic compounds. Sulphur, in chickpea, mainly influences the protein content. Sulphur helps towards conversion of nitrogen into protein in pulse crops. Sulphur also improves the S containing amino acid in crop and thus enhances the protein content" (Das et al*.,* 2016).

"Regular application of organics in amounts sufficient to meet the requirements of crops not only results in increasing crop yield but also improve the soil fertility and organic matter content" [9]. "Continuous use of inorganic fertilizers has brought loss of vital soil fauna and flora. Organic production systems maintained and improved the soil health through stimulating the activity of soil organisms and organic manures are also helpful in alleviating the increasing incidence or deficiency of secondary and micronutrients and is capable of sustaining crop productivity. Organic manures modify the soil physical behavior and increases the efficiency of applied nutrients" [10]. "Organic manures not only supply a higher amount of different nutrient elements but also contains beneficial microbes like nitrogen fixing bacteria, mycorrhizae and growth promoting substances for betterment of crops" [11].

"Vermicompost is usually a finely divided peat-like material with excellent structure, porosity, aeration, drainage and moisture-holding capacity" [12,13]. "It plays a vital role in dictating the biochemical cycles as it supports the growth and activities of soil micro flora. It enhances the colonization of *Mycorrhizae*, *Rhizobium, Azotobacter* and *Azospirillum* which in turn improve the nitrogen (N) as well as phosphorus (P_2O_5) supply and other micronutrients (Zn, Fe, Cu, Mn) besides imparting the resistance to plant against various soil borne diseases and insect

pest attack. It enhances the root growth due to better soil physico-chemical properties (soil structure, porosity, less bulk density, organic matter, water holding capacity and cation exchange capacity (CEC)" [14].

Keeping in view the significance of sulphur and vermicompost on growth parameters, yield attributes and seed yield of chickpea present investigation was undertaken at the Rajaula Agriculture farm, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.).

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out at Rajaula Agriculture farm, Mahatma Gandhi Chitrakoot Gramodaya Vishwavidyalaya Chitrakoot, Satna (M.P.) which lies in the semi- arid and sub-tropical region of Madhya Pradesh between 25.148° North latitude and 80.855°East longitude. The altitude of town is about 190-210 meter above mean sea level.

2.2 Edaphic Condition

The soil was moist, well drained with uniform plane topography. The soil of the experimental field was alluvial in origin, sandy loam in texture and slightly alkaline in reaction having pH 7.28 (1:2.5 soil: water suspension method given by Jackson, [15], low in organic carbon percentage in soil is 0.24 per cent Walkley and Black's rapid titration method given by [16], low in available nitrogen 98.00 kg ha^{-1} Alkaline permanganate method given by Subbiah and Asija, [17], medium in available phosphorus as sodium bicarbonate-extractable P was 17.31 kg ha^{-1} Olsen's calorimetrically method [18], high in available potassium was 219.98 kg ha^{-1} Flame photometer method given by [19] and low in available sulphur 25.41 kg ha^{-1} (Turbidimetric method given by Chesnin and Yien, 1950).

2.3 Experimental Details

The experiment was conducted with 4 levels of sulphur and 3 levels of vermicompost of 9 treatment combination as indicated show in Table 1.

2.4 Fertilizer and Manure Application

"FYM was applied @ 10 q ha^{-1} as basal dose. After the layout of experimental plot, the fertilizers were weighed and applied in the plots and thoroughly mixed with soil. As per the experimental recommended doses of Nitrogen, Phosphorus and Potassium were applied to all the plots. Recommended dose of Nitrogen, Phosphorus and Potassium were applied through Urea, DAP and MOP (20:40:20 kg ha^{-1}). Sulphur was applied at the time of sowing as per treatment" [14].

2.5 Seed and Sowing

The seed sowing was done on 20th Nov. 2022. The seed was sown in line after making a narrow furrow with the help of pointed wooden stick at different row spacing. The seeds were dropped in the furrow after mixture with fine dust of soil and then after seeds were covered with thin soil layer. The total quantity of seed was required @ 3.2 kg ha^{-1}. The chickpea variety was "GNG-1958 (Marudhar)".

2.6 Harvesting and Threshing

"The crop was harvested on 16th march, 2023 when it reached to its physiological maturity i.e. when the leaves were turned yellow and more than 70 % pod were full matured. Threshing of 17th March, 2023 plot wise produce was done manually. The seed weight was recorded after sun drying the seed for three days. The seed weight thus obtained were converted into quintals per hectare on the basis of net plot size" [14].

2.7 Statistical Analysis

The data on various characters studied during the course of investigation were statistically analyzed for factorial randomized block design. Wherever treatment differences were significant ("F" test), critical differences were worked out at

Table 1. Treatment details

Phosphorous Levels	Symbol	Vermicompost Levels	Symbol
0 kg ha^{-1}	S_0	0 ton ha^{-1}	V_0
15 kg ha^{-1}	S_1	2.5 ton ha^{-1}	V_1
20 kg ha^{-1}	S_2	5.0 ton ha^{-1}	V_2
25 kg ha-1	S_3		

five per cent probability level. The data obtained during the study were analyzed statistically using the methods advocated by Gomez and Gomez [20].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

It was clear from the Table 2 that growth parameters of chickpea were significantly influenced by the use of different sulphur levels and vermicompost levels. Plant height (cm) was significantly higher S @ 25 kg ha^{-1} as compared to S @ 20 kg ha^{-1} and S @15 kg ha^{-1}. The mean plant height (cm) at S_0, S_{15}, S_{20} and S_{25} were 35.26, 37.26, 38.90 and 41.80 cm. The mean plant height (cm) at V_1, V_2 and V_3 were 37.55, 38.37 and 39.00 cm. The mean no. of branches at S_0, S_{15}, S_{20} and S_{25} were 22.86, 24.33, 25.66 and 26.93. No. of branches was significantly higher in V_3 @ 5 t ha^{-1} as compared to V_2 @ 2.5 t ha^{-1} and V_1 @0 t ha^{-1}. The mean no. of branches at V_1, V_2 and V_3 were 24.47, 24.95 and 25.42. No. of nodule per plant was significantly higher S @ 25 kg ha^{-1} as compared to S @ 20 kg ha^{-1} and S @15 kg ha^{-1}. The mean no. of nodule per plant at S_0, S_{15}, S_{20} and S_{25} were 10.56, 11.33, 12.23 and 13.23 respectively. No. of nodule per plant was significantly higher in V_3@5 t ha^{-1} as compared to V_2@2.5 kg ha^{-1}and V_1 @0 t ha^{-1}. The mean no. of nodule per plant at V_1, V_2 and V_3 were 11.52, 11.85 and 12.15 respectively. These findings are further supported by Mir et al. [21] Joshi et al. [22], Kumar et al. [23] and Kumar et al. [24].

3.2 Yield Components

Data presented in Table 3 clearly indicated that the yield attributing characters such as number of pod plant^{-1}, number of seed plant^{-1} and seed index (g) were significantly influenced by the use of different sulphur levels and vermicompost levels. Number of pod plant^{-1}, number of seed plant^{-1} and seed index were significantly higher S @ 25 kg ha^{-1} as compared to S @ 20 kg ha^{-1} and S @15 kg ha^{-1}. The mean number of pod plant^{-1} at S_0, S_{15}, S_{20} and S_{25} were 34.03, 41.43, 50.40 and 58.56 respectively. The mean number of seed plant^{-1} at S_0, S_{15}, S_{20} and S_{25} were 33.43, 43.26, 52.66 and 61.76. The mean seed index at S_0, S_{15}, S_{20} and S_{25} were 20.58, 23.36, 24.97 and 26.77 g respectively.

Number of pod plant^{-1}, number of seed plant^{-1} and seed index (g) were significantly higher in V_3 @ 5.0 t ha^{-1} as compared to V_2 @ 2.5 t ha^{-1} and V_1 @ 0 kg ha^{-1}. The mean number of pod plant^{-1} at V_1, V_2 and V_3 is 43.35, 46.22 and 48.75 respectively. The mean number of seed plant^{-1} at V_1, V_2 and V_3 were 44.65, 47.55 and 51.15 respectively. The mean seed index at V_1, V_2 and V_3 were 23.06, 23.89 and 24.81 gm respectively. These findings are further supported by Islam et al. [25], and Ram and Katiyar [26].

3.3 Seed Yield

Seed yield of chickpea was illustrated in Table 4 was significantly influenced by the use of different sulphur levels and vermicompost levels at harvest stage. Seed yield (q ha^{-1}) at harvest

Table 2. Effect of different treatment combinations on growth parameters of chickpea

Treatment	Plant height (cm)	No. of branches	No. of nodules plant^{-1}
Sulphur levels			
S_0	35.26	22.86	10.56
S_{15}	37.26	24.33	11.33
S_{20}	38.90	25.66	12.23
S_{25}	41.80	26.93	13.23
S.E.m±	**0.23**	**0.23**	0.07
C.D. (P= 0.05)	**0.70**	**0.67**	0.22
Vermicompost levels			
V_1	37.55	24.47	11.52
V_2	38.37	24.95	11.85
V_3	39.00	25.42	12.15
S.E.m±	**0.20**	**0.19**	0.06
C.D. (P= 0.05)	**0.60**	**0.58**	0.19

Where S_0: Sulphur @ 0 kg ha^{-1}, S_{15}: Sulphur @ 15 kg ha^{-1}, S_{20}: Sulphur @ 20 kg ha^{-1}, S_{25}: Sulphur @ 25 kg ha^{-1}, V_1: Vermicompost @ 0 t ha^{-1}, V_2: Vermicompost @ 2.5 t ha^{-1}, V_3: Vermicompost @ 5 t ha^{-1}

Table 3. Effect of different treatment combinations on yield attributes of chickpea

Treatments	No. of pod plant^{-1}	No. of seeds plant^{-1}	Seed index
Sulphur levels			
S_0	34.03	33.43	20.58
S_{15}	41.43	43.26	23.36
S_{20}	50.40	52.66	24.97
S_{25}	58.56	61.76	26.77
S.E.m±	**0.43**	**0.39**	0.15
C.D. (P= 0.05)	**1.28**	**1.15**	0.46
Vermicompost levels			
V_1	43.35	44.65	23.06
V_2	46.22	47.55	23.89
V_3	48.75	51.15	24.81
S.E.m±	**0.37**	**0.34**	0.13
C.D. (P= 0.05)	**1.12**	**1.00**	0.40

Where S_0: Sulphur @ 0 kg ha^{-1}, S_{15}: Sulphur @ 15 kg ha^{-1}, S_{20}: Sulphur @ 20 kg ha^{-1}, S_{25}: Sulphur @ 25 kg ha^{-1}, V_1: Vermicompost @ 0 t ha^{-1}, V_2: Vermicompost @ 2.5 t ha^{-1}, V_3: Vermicompost @ 5 t ha^{-1}

Table 4. Effect of different treatment combinations on yields of chickpea

Treatments	Seed yield (q ha^{-1})
Sulphur levels	
S_0	13.33
S_{15}	14.80
S_{20}	15.80
S_{25}	16.96
S.E.m±	0.13
C.D. (P= 0.05)	0.39
Vermicompost levels	
V_1	14.75
V_2	15.27
V_3	15.65
S.E.m±	**0.11**
C.D. (P= 0.05)	**0.33**

Where S_0: Sulphur @ 0 kg ha^{-1}, S_{15}: Sulphur @ 15 kg ha^{-1}, S_{20}: Sulphur @ 20 kg ha^{-1}, S_{25}: Sulphur @ 25 kg ha^{-1}, V_1: Vermicompost @ 0 t ha^{-1}, V_2: Vermicompost @ 2.5 t ha^{-1}, V_3: Vermicompost @ 5 t ha^{-1}

stage was significantly higher S @ 25 kg ha^{-1} as compared to S @ 20 kg ha^{-1} and S @15 kg ha^{-1}. The mean seed yield (q ha^{-1}) at S_0, S_{15}, S_{20} and S_{25} were 13.33, 14.80, 15.80 and 16.96 q ha^{-1} respectively at harvest stage. Seed yield (q ha^{-1}) at harvest stage was significantly higher in V_3 @ 5.0 t ha^{-1} as compared to V_2@2.5 t ha^{-1} and V_1 @0 t ha^{-1}. The mean seed yield (q ha^{-1}) at V_1, V_2 and V_3 were 14.75, 15.27 and 15.65 q ha^{-1} respectively at harvest stage. These findings are further supported by the findings of Srinivasulu et al. [27], Singh et al. [28], Bera and Ghosh [29] and Makol et al. [30].

4. CONCLUSION

The experimental findings revealed that superiority in regard to growth parameters, yield components and productivity parameters *viz,* grain yield (q ha^{-1}) with the use of treatment combination S @ 25 kg ha^{-1} and V @ 5 t ha^{-1} gave in soil ensure highest growth parameters, yield components and productivity, of barley crop as comparison to all the treatments.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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