IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Effect Of Phosphorus And Sulphur On Yield Of Chickpea (*Cicer Arietinum* L.)

Vikash Kumar Meena[1], P.K. Sharma[2], Nischay Gautam[3] ,Kamal Kumar Bairwa[4]

[1]Department of Agronomy, Vivekananda Global University, Sector 36, Jagatpura Jaipur, Rajasthan 303012

[2]Department of Agronomy, Vivekananda Global University, Sector 36, Jagatpura Jaipur, Rajasthan 303012

[3]Department of Agronomy, Vivekananda Global University, Sector 36, Jagatpura Jaipur, Rajasthan 303012

[4]Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Vidya Vihar, Rae Bareli Road, Lucknow, U.P. 226025

A B S T R A C T

The experiment was conducted during Rabi 2023-24 the "Effect of Phosphorus and Sulphur on Yield of Chickpea (*Cicer arietinum* L.)" at Research Farm, Vivekananda Global University, Jaipur. The experiment was layout in RBD having 12 treatment combinations consisting of four P levels (0, 20, 40, 60 kg P2O5 ha-1), three S levels (15, 30, 45 kg ha-1). The soil of the experimental field was loamy in texture with low organic carbon (0.15-0.31%) and available N (141.51-152.30 kg ha-1) and medium in available P (15.25-19.30 kg ha-1) and available K (238-246.70 kg ha-1). The chickpea variety 'RSG-888 (Anubhav)' was sown at the rate of 80 kg seed ha-1 in lines at 30 cm apart on 25th October 2023. The Application of P and S significantly increased the number of pods plant-1, seed pod-1 and seed and straw yields, protein content in seed and straw, total uptake of N, P and S by chickpea up to 60 kg P_2O_5 ha-1 and 45 kg S ha-1. The highest net income and benefit: cost ratio was obtained with the application of 60 kg P_2O_5 ha-1 + 45 kg ha-1.

Introduction

Chickpea (Cicer arietinum L.) is an important grain legume in Asia. Being rich and cheap source of protein, it can help people to improve the nutritional quality of their diet. Chickpea is relatively of minor importance on the world market but it is extremely important for local trade in numerous tropical and subtropical regions. It is grown and consumed in large quantities from South East Asia to India and in the Middle East and Mediterranean countries. Chickpea is the third most important pulse crop in the world after French bean (Phaseolus vulgaris L.) and field peas (*Pisum sativum* L.).

Mostly chickpea is grown in South Asia, which accounts for more than 75% of the world chickpea area. It is also the premier food legume crop in India, ranks first among all pulse crops, covering about 9.58 mha area with production of 9.33 MT and productivity of 973 kg/ha (Anonymous, 2022-23). In Rajasthan chickpea crop is cultivated in 1.57 mha areas with production of 1.67 MT and productivity of 1062 kg /ha. It occupies about 30% of total cultivated area of pulses and contributes 40% of total pulse production. India

is the largest producer of chickpea contributing highest share in area (65.3%) and production (67.2%) in the world (FAO, 2022).

The majority of our farmers hardly ever fertilize or use manure when growing legumes. The average yield and yield potential of this crop differ significantly, thus there is a chance to increase productivity by optimal management and fertilization.

Fertilizers containing phosphorus, which are frequently added to soil to increase crop yields, quickly react with calcium and gradually lose their availability to plants. The first crop uses only roughly 15-20% of the supplied phosphorus. Thus, there is a global trend currently underway to investigate the potential of using other sources of nutrients to boost the effectiveness of chemical fertilizers. Because reserve phosphate or rock phosphate, has very little or no phosphorus available to it in neutral and alkaline soil.

A serious limitation on crop productivity, produce quality, fertilizer use efficiency, and economic returns on millions of farms is being caused by the increasingly severe sulphur deficit that is occurring every year. Like any other necessary nutrient, sulphur has a few specific tasks for the plant to do. According to Tandon and Messick (2007), the only way to remedy sulphur deficits is to apply sulphur fertilize.

Surveys were conducted from time to time to assess the sulphur (S) status of soil and they showed that the soils of rainfed area are different in sulphur. Soil have become deficient in S due to cultivation of high yielding varieties, use of high grade Sulphur. Sulphur fertilizer are known to enhance crop yield and uptake of macronutrients especially nitrogen. Application of fertilizer to alkaline soils has been reported to reduce the pH of soil (Taalab et al. 2008).

Among the various constraints attributing to low productivity of chickpea are poor soil fertility, traditional method of growing chickpea and non-availability of improved techniques. Soil health deterioration is the prime threat to Indian agriculture which is being aggravated with excessive use of fertilizers in less responsive soils of arid region with low organic matter content. The better alternative is integrated use of chemical fertilizers with organic manure and biofertilizers which ensured high crop production along with maintaining soil health and fertilizer use efficiency.

Phosphorus (P) is an essential nutrient both as a part of several key plant structural compounds and as a catalyst in the conversion of numerous key biochemical reactions in plants. P is noted especially for its role in capturing and converting the sun‟s energy into useful plant compounds; thus P is essential for the general health and vigor of plants. Some specific growth factors that have been associated with P are: stimulated root development, increased stalk and stemstrength, improved flower formation and seed production, more uniform and earlier crop maturity, increased nitrogen N-fixing capacity of legumes, improvements in crop quality, and increased resistance to plant diseases. Phosphorus transformations and mobility in the soil-plant system are controlled by a combination of biological, chemical and physical processes. The amounts, forms and associated dynamics of soil P are influenced by a number of factors including soil type and environmental conditions, as well as land-use and management practices. In natural ecosystems plant growth is often limited by P availability, while P is generally recycled and retained efficiently. However, in managed ecosystems continued inputs of P in the form of fertilizers affect the quantity, availability and dynamics of soil P.

Sulphur is the most vital nutrients for growth and development of plants. Sulphur is considered to be the fourth important essential nutrient after nitrogen, phosphorus and potassium for the plant growth. Sulphur performs many physiological functions like synthesis of cysteine, methionine, chlorophyll and protein in pulses. It is also responsible for synthesis of certain vitamins (B, Biotin and Thiamine), metabolism of carbohydrate, protein and oil formation of flavour compounds in crucifers. In recent years, sulphur deficiency has been aggravated in the soil due to continuous removal by crops and use of high analysis

devoid of Sulphur coupled with intensive cropping with high yielding varieties and reduction in use of organic manure and sulphur containing fungicides and insecticides. With the adoption of intensive farming the farmer have shifted from organic to inorganic high analysis S-free fertilizer leading to more widespread and more intense S deficiency. Indian soil in early 1990, s estimated to occur in about 130 District and recently about 45% districts of our country i.e. more than 40% S deficiency.

Materials and Methods

A field experiment entitled to "Effect of Phosphorus and Sulphur on Yield of Chickpea (*Cicer arietinum* L.)" under Rainfed Conditions" was conducted at Research Farm, Vivekananda Global University, Jaipur during Rabi season of 2023-24. Geographically, the study area is located at 0750 88'99" E longitude and 260 81'17" N latitude and this region falls under agro-climatic zone III A of Rajasthan (Semi-arid Eastern Plain Zone). The region receives mean annual rainfall of about 400 mm, out of which about 80% is concentrate from mid-June to end of September. The winter months are very cold, whereas summer months are hot and dry. Westerly hot winds start from the month of April and continue till the onset of monsoon. The experimental was laid out in a randomized block design with 12 treatments combinations comprised of four phosphorus levels (0, 20, 40, 60 kg/ha), three sulphur levels (15, 30, 45 kg S/ha) with three replications. *i.e*. T_1 (P_2O_5 Control + 15 Kg ha-1 Sulphur), T_2 (P_2O_5 Control + 30 kg ha-1 Sulphur), T_3 (P_2O_5 Control + 45 kg ha-1 Sulphur), T_4 (20 kg ha-1 P_2O_5 + 15 kg ha-1 Sulphur), T_5 (20 kg ha-1 P_2O_5 + 30 kg ha-1 Sulphur), T_6 (20 kg ha-1 P_2O_5 + 45 kg ha-1 Sulphur), T_7 (40 kg ha-1 P_2O_5 + 15 kg ha-1 Sulphur), T_8 (40 kg ha-1 P_2O_5 + 30 kg ha-1 Sulphur), T_9 (40 kg ha-1 P_2O_5 + 45 kg ha-1 Sulphur), T_{10} (60 kg ha-1 P_2O_5 + 15 kg ha-1 Sulphur), T_{11} (60 kg ha-1 P_2O_5 + 30 kg ha-1 Sulphur), T_{12} (60 kg ha-1 P_2O_5 + 45 kg ha-1 Sulphur). Phosphorus and sulphur both was applied through DAP and elemental sulphur respectively as basal dose.

The experimental plot was loamy sand in texture, pH (8.23), low in organic carbon (0.19), and available nitrogen (145.51 kg/ha), available phosphorus (18.92 kg/ha). Chickpea variety "RSG-888(Anubhav)" was use as test variety in this experiment. chickpea variety sowing on 25 October 2023 with 30*10 cm spacing and harvest on 25 March 2024.

Results and Discussion

Effect of phosphorus and sulphur on yield parameters

Effect of phosphorus

The application of 60 kg P2O5/ha being at par with 40 kg P2O5/ha (table 1) recorded more dry weight /plant at all the stages of crop growth during the year. The application of 60 kg P2O5/ha, recorded significantly more values of number of pods /plant and number of seed /pod over other levels of phosphorus during the year. The maximum seed and stover yield were found with the application of 60 kg P2O5/ha which was significantly higher over other levels of phosphorus during the year. The application of 60 kg P2O5/ha being at par with 40, 20 kg P2O5/ha, recorded more nitrogen content in stover over control during the year. The application of 60 kg P2O5/ha, recorded significantly higher nitrogen content in seed over other levels of phosphorus during the year. The application of 60 kg P2O5/ha recorded significantly higher phosphorus content in seed over other levels of P2O5/ha during both years. The application of 60 kg P2O5/ha being at par with 40, 20 kg P2O5/ha recorded significantly higher phosphorus content in stover over control treatment during the year. The application of 60 kg P2O5/ha, recorded significantly more nitrogen uptake by seed and stover and total nitrogen uptake by crop over rest of the treatment during the year of study. The maximum phosphorus uptake by seed, stover and crop was recorded with the application of 60 kg P2O5/ha(table 2) which was at par with 40, 20 kg P2O5/ha and significantly superior over control during the year. Application of P resulted a significant increase in yield contributing characters likes number of pods/plant, number of seeds/pod and test weight with increasing levels of P up to 60 kg P2O5/ha. Phosphorous application accelerated the production of photosynthesis and their translocation from source to sink, which ultimately gave the higher values of yield contributing

characters. Increase in yield contributing characters has been reported by Tiwari et al. (2001), Chaudhary and Goswami (2005), Singh et al. (2005), Meena et al. (2006), Bairwa et al. (2012), Verma et al. (2017), Dharwe et al. (2019) with increasing levels of P.

Effect of sulphur

The application of 45 kg S/ha recorded significantly more values of number of pods /plant, number of seed /pod over 30 and 15 kg S/ha during the year. The maximum seed and stover yields (table-1) were found with the application of 45 kg S/ha, which was significantly higher over 30 and 15 kg S/ha during the year. The application of 45 kg S/ha, recorded significantly higher sulphur content in stover over 30 and 15 kg S/ha treatment during the year. Nitrogen uptake by seed and stover and total nitrogen uptake by crop recorded maximum with the application of 45 kg S/ha, which was significantly higher over 30 and 15 kg S/ha during the year. The maximum sulphur uptake by seed, stover and crop was recorded with the application of 45 kg S/ha, which was significantly higher over 30 and 15 kg S/ha during the year. Application of S resulted a significant increase in yield contributing characters likes number of pods/plant, number of seed/pod with the application of sulphur 45 kg/ha, which ultimately gave the higher values of yield contributing characters. Application of S increased the seed and stover yields (table 1) significantly with the application of 45 kg/ha. Maximum seed yield of 2156.9 kg/ha was obtained with the application of 45 kg/ha; Increase in yield contributing characters has been reported by Bairwa et al. (2012), Verma et al. (2017), Dharwe et al. (2019).

Table.1 Effect of phosphorus and sulphur on seed yield (kg/ha), stover yield (kg/ha) and test weight (g) of chickpea.

Treatment Characters	Seed yield (kg/ha)	Stover yield (kg/ha)	Test weight (g)
Phosphorus levels (kg/ha)			
0	1864.5	2145.7	193.7
20	1976.3	2192.3	195.9
40	2070.5	2310.1	199.3
60	2180.7	2540.5	203.3
SEm±	22.95	37.16	2.33
CD at 5%	**71.44**	**115.66**	**7.26**
Sulphur levels (kg/ha)			
15	1989.7	2194.4	191.5
30	2148.1	2440.9	193
45	2156.9	2490.3	195.5
SEm±	33.69	15.47	1.48
CD at 5%	**109.87**	**50.46**	**4.83**

Table.2 Effect of phosphorus and sulphur on nitrogen content and uptake in seed and stover of chickpea.

Characters	Nitrogen Content (%)		Nitrogen Uptake (kg/ha)		
Treatment	**Seed**	**Stover**	**Seed**	**Stover**	**Total**
Phosphorus levels (kg/ha)					
0	2.95	0.58	51.14	11.8	62.94
20	3.02	0.6	55.75	12.3	68.05
40	3.1	0.62	62.47	14.67	77.14
60	3.16	0.65	67.14	15.4	82.54
SEm±	0.02	0	0.27	0.15	0.69
CD at 5%	0.07	0.01	0.83	0.45	2.16
Sulphur levels (kg/ha)					
15	3.12	0.6	63.26	13.57	76.83
30	3.16	0.63	66.96	14.26	81.22
45	3.19	0.65	67.03	15.1	82.13
SEm±	0.05	0.01	1.3	0.07	0.71
CD at 5%	0.16	0.03	4.23	0.23	2.32

Conclusion

Crop on the basis of results obtained from the present study conducted following conclusions are being made:

1. A dose of 60 kg/ha P_2O_5 + 45 kg/ha Sulphur proved to be most suitable for chickpea cultivation.
2. A chickpea crop grown with 60 kg 60 kg/ha P_2O_5 + 45 kg/ha gave higher net income and benefit-cost ratio

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