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Effect of sulphur and iron on growth, yield and quality of chickpea

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Abstract
A field experiment was carried out during *Rabi* season of 2021-22 at Agronomy Farm, B. A. College of Agriculture, and Anand Agricultural University, Anand (Gujarat) to study the effect of sulphur and iron on growth, yield and quality of chickpea. The experiment was carried out using twelve treatment combinations consisted of four levels of sulphur (0, 10, 20 and 30 kg/ha) and three levels of iron (0, 5 and 10 kg/ha) which were tested under randomized block design (factorial). Results of the experiment revealed that the treatment receiving 30 kg S/ha significantly increased the plant height, number of branches/plant, number of pods/plant, seed and haulm yield of chickpea as well as crude protein in seed. Among different levels of iron, significantly maximum plant height, number of branches/plant, number of pods/plant, seed and haulm yield of chickpea were found with the application of 10 kg Fe/ha.

Keywords: Chickpea, sulphur, iron, growth, yield, quality

Introduction
The chickpea (*Cicer arietinum* L.) commonly known as “Gram” or “Bengal gram”, is India's most important and prominent pulse crop. Chickpeas have been well-organized as a valuable source of protein, especially in underdeveloped nations where majority of the population depends on low-cost food to meet their nutritional demands. The consumption of 14 g chickpea on a routine basis provides nearly 2.3 % (56 Kcal) calories and 4.7 % (2.7 g) protein to the Indian population. In addition, it is being a key source of calcium and iron (10-12%). India is the world's leading producer and importer of leguminous crops. India leads the world in chickpea production as it accounting for 25-28 % of overall crop production, but has low chickpea productivity. India is the world’s largest producer of chickpeas, with a 106 lakh ha area, a production of about 111 lakh tons and productivity of 1056 kg/ha. India imports approximately three million tons (mt) of pulses in the year 2020- 21 (Anonymous, 2020) [1]. Chickpea has several potential health benefits and in combination with other pulses and cereals, it could have beneficial effects on some of the important human diseases such as cardiovascular diseases, diabetes, digestive diseases and some cancers. Overall, chickpea is an important pulse crop with a diverse array of potential nutritional and health benefits (Jukanti *et al*., 2012) [6]. Sulphur is one of the seventeen essential plant nutrients and ranks 4th major nutrient next to N, P and K because of its important role in proteins, vitamins, enzyme and flavoured compounds in plant (Bera and Ghosh, 2015) [2]. It involved in the synthesis of chlorophyll and some plant hormones such as thiamine and biotin and also important constituent of iron sulphur proteins called ferrodoxins. It is a constituent of three sulphur containing amino acids *viz.*, cysteine, cystine and methionine, which are the building blocks of protein. Iron aids in the synthesis of chlorophyll and is a key component of the *nitrogenase* enzyme, which is required for nitrogen fixation. It plays a crucial role in the metabolism of nucleic acids. It is a structural component of hemes, hematin and leghaemoglobin. It activates a variety of enzymes, including aminolevolinicacid *synthetize and coproporphyrinagen oxidase* (Kumar *et al*., 2020) [10]. Keeping these importances of sulphur and iron in mind this experiment was planned.

Materials and Methods
To find out the effect of sulphur and iron on growth, yield and quality of chickpea (*Cicer arietinum* L.), a field experiment was carried out on Agronomy Farm,

BA College of Agriculture, Anand Agricultural University, Anand during *Rabi* season of the year 2021-22. The experiment comprising 12 treatment combinations consisted of four levels of sulphur (0, 10, 20 and 30 kg/ha) and three levels of iron (0, 5 and 10 kg/ha). These treatments were evaluated in Randomized Block Design (factorial) with three replications. The soil of the experimental field was loamy sand in texture, low in organic carbon, available nitrogen and DTPA extractable- iron, medium in available phosphorus, potassium and sulphur. The treatments comprised of T1- sulphur 0 kg/ha + iron 0 kg/ha, T2- sulphur 0 kg/ha + iron 5 kg/ha, T3- sulphur 0 kg/ha + iron 10 kg/ha, T4- sulphur 10 kg/ha + iron 0 kg/ha, T5- sulphur 10 kg/ha + iron 5 kg/ha, T6- sulphur 10 kg/ha + iron 10 kg/ha, T7- sulphur 20 kg/ha + iron 0 kg/ha, T8- sulphur 20 kg/ha + iron 5 kg/ha, T9- sulphur 20 kg/ha + iron 10 kg/ha, T10- sulphur 30 kg/ha + iron 0 kg/ha, T11- sulphur 30 kg/ha + iron 5 kg/ha, T12- sulphur 30 kg/ha + iron 10 kg/ha. The recommended dose of fertilizer is 20:40:00 NPK kg/ha. The N, P, S and Fe nutrients were applied by using source of Urea, DAP, Bentonite sulphur and Ferrous sulphate, respectively. The chickpea variety "Gujarat Gram 5" was sowing in first fourth night of November with spacing of 45 m × 10 m and seed rate of 60 kg/ha. The crop was raised with all the standard package of practices and protection measures were also timely carried out as required. The experimental data were recorded for growth, yield and quality time to time and statistically analyzed for level of significance.

Results and Discussion

Effect of sulphur

The data pertaining to growth and yield of chickpea as significantly influenced by different sulphur levels was given in Table 1. The treatment receiving 30 kg S/ha (S30) recorded significantly higher plant height at harvest (48.30 cm) and number of branches/plant (7.04) over control but was remained par with treatment receiving 20 kg S/ha (S20). This might be due to the fact that sulphur is involve in the formation of chlorophyll and thereby encourages vegetative growth. This result collaborates with the findings of Khatkar *et al*. (2007) [8], Kaisher *et al*. (2010) [7] and Jadeja *et al*. (2016) [5]. Significantly maximum number of pods/plant (52.47) were observed with the application of 30 kg S/ha (S30) compared to rest of the treatments. This increase might be due to sulphur availability resulting into better formation of nodules, nitrogenase enzyme, chlorophyll which directly improves growth and photosynthesis activity. Similar results were observed by Noman *et al*. (2015) [12] and Das (2017) [3].

The treatment receiving 30 kg S/ha (S30) recorded significantly maximum seed and haulm yield of chickpea (2427 and 3566 kg/ha, respectively) over different levels of sulphur except treatment receiving 20 kg S/ha (S20) in case of haulm yield of chickpea. The increase in yield of chickpea might be due to better availability of available nutrients in the soil and higher uptake of nutrients by plant which ultimately led to effective assimilate partitioning of photosynthesis from sources to sink in post-flowering stage. This result collaborates with the findings of Meena *et al*. (2013) [11] and Ray *et al*. (2015) [15].

The crude protein (20.67%) in chickpea seed was found significantly higher with the treatment of application of 30 kg S/ha (S30) and was found to be at par with treatment of application of 20 and 10 kg S/ha (S20 and S10, respectively). The sulphur plays an important role in synthesis of S containing amino acids, namely methionine, cysteine and cystine resulted in increased in protein content in chickpea. Similar results were observed by Patel *et al*. (2014) [13], Srinivasulu *et al*. (2015) [17] and Yadav *et al*. (2020) [18].

Effect of Iron

All the growth and yield parameters were significantly influenced by the application of different levels of iron excluding the plant height measured at 45 DAS (Table 1). The plant height (47.47 cm) and number of branches/plant (6.94) at harvest were found significantly higher under treatment Fe10 (10 kg Fe/ha) and were found to be at par with treatment Fe5 (5 kg Fe/ha).This might be due to the increase in the availability of iron to the plant might have stimulated the metabolic and enzymatic activities thereby increasing the growth of the plant. Similar results were observed by Kumar *et al*. (2020) [10]. The treatment Fe10 (10 kg Fe/ha) recorded significantly highest number of pods/plant (51.34) over rest of the treatments. The iron is essential for plant functions such as, chlorophyll development, energy transfer within the plant, acts as a constituent of enzymes and proteins and also for plant respiration and plant metabolism which improves photosynthesis, therefore helps to increase in number of pods in chickpea. This result collaborates with the findings of Meena *et al*. (2013) [11] and Gahlot *et al*. (2020) [4].

Table 1: Effect of sulphur and iron on growth, yield and quality of chickpea

Treatments	Plant Height (cm)		No. of branches/plant	No. of pods /plant	Seed yield (kg/ha)	Haulm yield (kg/ha)	Crude protein (%)
	45 DAS	AT Harvest					
S levels (kg/ha)							
S0	27.71	42.37	6.36	45.50	1962	3111	19.53
S10	28.52	44.73	6.63	47.57	2093	3242	20.15
S20	29.19	46.26	6.89	49.04	2232	3405	20.38
S30	30.88	48.30	7.04	52.47	2427	3566	20.67
S.EMm±	0.77	1.09	0.13	1.13	62	101	0.27
CD (p = 0.05)	NS	3.19	0.28	3.32	182	297	0.79
Fe levels (kg/ha)							
Fe0	28.11	42.84	6.53	46.38	2052	3119	19.76
Fe5	29.06	45.93	6.72	48.22	2116	3365	20.29
Fe10	30.06	47.47	6.94	51.34	2323	3509	20.49
S. Em±	0.66	0.94	0.11	0.98	54	88	0.23
CD (p = 0.05)	NS	2.77	0.32	2.97	158	257	NS
S. Em±	1.34	1.89	0.22	1.96	108	175	0.47
Interaction S x Fe	NS	NS	NS	NS	NS	NS	NS
CV (%)	7.96	7.19	5.70	6.97	8.55	9.11	4.02

The treatment receiving application of 10 kg Fe/ha (Fe10) produced significantly maximum seed yield (2323 kg/ha) of chickpea over control (Fe0). The application of iron sulphate plays an important role in synthesis of chlorophyll, plant growth regulator, improves photosynthesis, assimilates transportation to sink and finally results in increases in seed yield. Similar result was observed by Patel *et al*. (1993) [14] and Kuldeep *et al*. (2018) [9]. Similarly, treatment Fe10 (10 kg Fe/ha) recorded significantly maximum haulm yield (3509 kg/ha) than other treatments but was remained at par with treatment Fe5 (5 kg Fe/ha). The iron is essential for plant functions such as, chlorophyll development, energy transfer within the plant and constituent of certain enzymes. As plant height and number of branches/plant increases which directly results in increased in haulm yield of chickpea. Similar results were also reported by Patel *et al*. (1993) [14], Singh *et al*. (2016) and Kuldeep *et al*. (2018) [9]. Different levels of iron failed to produce any significant results in case of crude protein of chickpea.

Interaction Effect of sulphur and iron

The interaction of sulphur and iron had not exerted significant change on growth, yield parameters and quality of chickpea.

Conclusion

From the above results it can be concluded that the application of 30 kg sulphur/ha as well as 10 kg iron/ha is found optimum for securing higher growth and yield of chickpea. Application of 30 kg sulphur/ha is found optimum for improving crude protein in chickpea seed.

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