J. appl. Res in Plant Sci. **Vol. 1(1), 9-12** https://doi.org/10.38211/joarps.2020.1.1.2
www.joarps.org.

EFFECT OF SULPHUR APPLICATION ON GROWTH AND YIELD OF CHICKPEA (*CICER ARIETINUM* L.) UNDER RICE CHICKPEA CROPPING SYSTEM

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Article Received 20-04-2020, Revised 28-04-2020, Accepted 7-05-2020

ABSTRACT

Chickpea (*Cicer arietinum* L.) is the most important nutritive pulse crop which is cultivated throughout the world. A field experiment was conducted in order to study the effect of sulphur on growth and yield of chickpea (*Cicer arietinum* L.) under rice chickpea cropping system. A commercial chickpea variety DG-89 was used for this study under five treatments T_1 = 36-72 kg NP ha^{-1} + 0 kg S ha^{-1} (Control), T_2 = 36-72 kg NP ha^{-1} + 20 kg S ha^{-1}, T_3 = 36-72 kg NP ha^{-1} + 40 kg S ha^{-1}, T_4 = 36-72 kg NP ha^{-1} + 60 kg S ha^{-1} and T_5 = 36-72 kg NP ha^{-1} + 80 kg S ha^{-1}. The results of the study showed that the application of 36-72 kg NP ha^{-1} + 40 kg S ha^{-1}, resulted maximum plant height, more pods plant^{-1}, higher number of branches plant^{-1}, maximum seed index 1000 grain weight and more grain yield over control. The maximum nitrogen and phosphorous content in chickpea were noted due to S application @ 36-72 kg NP ha^{-1}+ 40 kg S ha^{-1}. It is concluded that for better growth and yield of chickpea sulphur application @ 40 kg S ha^{-1} should be included in the fertilization program of chickpea along with recommended NP (36-72 kg NP ha^{-1}) under rice chickpea cropping system.

Keywords: chickpea, sulphur, rice chickpea, cropping system.

INTRODUCTION

Chickpea (*Cicer ariatinum* L.) is the most significant pulse crop of the world that is cultivated and consumed across the world. It is an extremely nourishing grain legume crop and is one of the cheapest protein sources (Islam *et al.*, 2009). Pakistan is the 4th largest chickpea producing country in the world (GoP, 2018). It is also an important legume crop of Pakistan that is cultivated on greater than one million hectares of the land (Annonymous, 2011). However, the chickpea production of Pakistan (514.7 kg ha^{-1}) is much lower than the other countries of the world such as Algeria (956 kg ha^{-1}), Bangladesh (940 kg ha^{-1}), India (931.6 kg ha^{-1}), Tanzania (902 kg ha^{-1}), Russia (893 kg ha^{-1}) and Spain (800 kg ha^{-1}) (Omar *et al.*, 2017). The factors which are responsible for decreasing the chickpea yield are imbalance fertilization, insects, pests and diseases attack and lodging by winds and grain shriveling due to a sudden rise in temperature at grain maturity (Andrieu *et al.*, 2015). Sulphur is the 4th most important plant nutrient after nitrogen, phosphours and potassium, and it plays an important role in electrochemical function of biomolecules in the cell (Saito, 2004). Majority of the soils of Pakistan are deficient in sulphur. Generally, the legumes have need of almost equal quantity of sulphur and phosphorus (Khalid *et al.*, 2009). When phosphorus and sulphur is available under the critical level of soil, the quality of produce and plant growth is affected (Duke *et al.*, 1970). Sulphur fertilizer is recognized to augment the crop produce and macronutrients uptake especially most of them nitrogen (Islam *et al.*, 2012). Sulphur application to alkaline soils decreases soil pH. However, information concerning sulphur fertilizers effects on the micronutrients particularly copper, zinc, manganese and iron availability and uptake by plants crops is very rare (Taalab *et al.*, 2008). Research work in Pakistan regarding the relation of S and P and its critical role in the growth of legume is very unusual. Understanding sulphur's role in growth and development of pulses is very much important from the viewpoint that the deficiency of sulphur in soils is increasing (Sexton *et al.*, 1998). The purpose of the current study is to observe the response of chickpea

against sulphur applications and to assess the S fertilization effect on P, N and S content of chickpea.

MATERIALS AND METHODS

A field experiment was carried out on residual plots after the harvest of rice crop at Quaid-e-Awam Agriculture Research Institute (QAARI) Larkana (located between 27.59 N and 68.26 E). Commercial Chickpea variety DG-89 was used for this study. The seedbed preparation was done by using mould board plough, cultivator and rotavator. The seed was sown through the drilling method. Plant RXR distance was 30 cm and row length were 3 meters. The seed rate was applied @ 80 kg ha^{-1}. The fertilizers sources were di-ammonium phosphate, urea and gypsum as a source of sulphur. All fertilizers were broadcasted; however, the urea application was applied in three equal splits. Before of the experiment, the sampling of the soil was carried out by stainless steel auger. After preparation of the field samples, they were analysed for physical and chemical properties of the soil. The analysis showed that the soil was clay loam in texture, alkaline in pH (7.90), non-saline (0.24 dS m^{-1}), poor in soil organic matter (0.95%) and moderate in sulphur concentration (9.50 mg). The experiment was carried out under randomized complete block design (RCBD) with 05 treatments T_1 = (36-72 kg NP ha^{-1} + 0 kg S ha^{-1}), T_2 = (36-72 kg NP ha^{-1} + 20 kg S ha^{-1})**,** T_3 = (36-72 kg NP ha^{-1} + 40 kg S ha^{-1})**,** T_4 = 36-72 kg NP ha^{-1} + 60 kg S ha^{-1} and T_5 = (36-72 kg NP ha^{-1} + 80 kg S ha^{-1}) and 03 replicantions. The plot size was 5X3= 15 m². The agronomic parameters, (emergence%, plant height, number of branches $plant^{-1}$, pods $plant^{-1}$, seed index 1000 grain weight grams and grain yield) was recorded. After the crop harvest, the plant materials were analyzed for total nitrogen, phosphorus, potassium and sulphur ions. The data was analyzed statistically for analysis of variance (ANOVA) by using statistical software (Statistix 8.1). For the determinations of difference in treatment, Duncan's Multiple Range Test (DMRT) was applied at 0.05 alpha levels (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The results of the experiment shown the significant effect (*P≤0.05*) on chickpea growth parameters, i.e., plant height, number of branches $plant^{-1}$**,** seed index, number of pods $plant^{-1}$ and on the yield of grain (t ha^{-1}) while the non-significant effect (*P≤0.05*) of chickpea plants were observed on emergence % (Table 1). The maximum emergence of 91% of plants were noted on treatment 36-72-0+40 NPS kg ha^{-1} and minimum 89% emergence of plants were observed on control treatment (36-72-0+ 00 kg S ha^{-1}). Growth and yield indicators were directly proportional to sulphur rates. However, the intensity of increase was found variable among parameters due to synergistic effect of sulphur with nitrogen and phosphorus. e.g. plant height increased from 16 to 37%, a number of branches from 28 to 54%, seed index (1000 grain weight grams) from 43 to 86%, grain yield from 9 to 16% and number of pods per $plant^{-1}$ from 5 to 10% when different rates of S applied as compared to control. In this study, S applied @ 40 kg ha^{-1} considerably enhanced all the studied parameters.

Similar results of increasing agronomic parameters growth and yield parameters were obtained by many researchers. Islam *et al.* (2009) concluded that the sulphur fertilization increased seed yield up to 17% as compared to control. Nawange *et al.* (2011) documented that the sulphur dose @ 40 kg ha^{-1} produced the maximum mean 1665 Kg ha^{-1} seed yield and 2665 Kg ha^{-1} stalk yield. Petal *et al.* (2012) noted that the application of sulphur had considerably influenced on yield and growth assigning characters over control treatments. Muhammad *et al.* (2016) observed that the sulphur and phosphorus application considerably increased yield of seed (27% to 41% and 7% to 11%) of chickpea over control.

The results of the experiment further indicated that N, P and S concentration in chickpea leaves increased with increasing sulphur rates (Table 2). The increase was variable among nutrients as N and P both increased in terms of concentration from 5 to 33%, and sulphur from 2 to 4% when different rates of S applied along with N and P as compared to control. This is due to the synergistic relationship of N and P in response to S application. The sulphur treatments effect 20, 40 and 60 kg S ha^{-1} was more profound on nitrogen and P concentration. However, the sulphur concentration of chickpea steadily increased with increasing S rates. The similar results of increasing N, P and S content were reported by many researchers. Muhammad *et al.* (2016) documented that the increasing rates of phosphorous 0, 40, 80 kg ha^{-1} considerably enhanced sulphur, nitrogen and phosphorous nutrients uptake in plants. Alukh and Pasricha (2017) reported that the sulphur @ S 40 kg ha^{-1} enhanced protein%, nitrogen% and sulphur content in grai

Table 1. Effect of sulphur application on emergence %, plant height, number of branches, seed index, number of pods plant^{-1}, grain yield (t ha^{-1}) of chickpea.

Treatments	Emergence (%)	Plant height (cm)	Number of Branches	Seed Index	Number of pods plant^{-1}	Grain yield (t ha^{-1})
36-72-0+ 00 kg S ha^{-1}	89.00 ± 0.58 a	26.33 ± 0.88 c	14.33 ± 0.88 b	195.00 ± 2.08 c	55.33 ± 1.76 b	2.602 ± 0.79 c
36-72-0+ 20 kg S ha^{-1}	90.00 ± 0.58 a	30.66 ± 0.88 bc	18.33 ± 1.20 a	279.00 ± 1.53 b	58.33 ± 0.88 ab	2.866 ± 0.25 b
36-72-0+ 40 kg S ha^{-1}	91.00 ± 0.58 a	36.00 ± 1.53 a	22.00 ± 0.58 a	363.67 ± 2.19 a	61.00 ± 1.15 a	3.043 ± 0.36 a
36-72-0+ 60 kg S ha^{-1}	90.00 ± 0.58 a	32.33 ± 0.88 ab	20.00 ± 0.58 a	283.33 ± 2.60 b	59.33 ± 0.88 ab	2.998 ± 1.17 ab
36-72-0+ 80 kg S ha^{-1}	90.00±0.08a	31.33 ± 0.67 ab	20.00 ± 0.58 a	279.00 ± 1.73 b	59.00 ± 0.58 ab	2.998 ± 0.80 ab
SE	0.687	0.687	0.024	0.584	2.712	1.542
LSD 5%	2.201	2.201	0.034	1.759	8.324	4.652

Each value is a mean ± SE of three replicates; Different letters in a column represent significant difference among treatments ($P \leq 0.05$) as a function of sulphur application.

Table 2. Effect of sulphur application on nitrogen, phosphorous and sulphur content (%) in chickpea

Treatments	Nitrogen %	Phosphorus %	Sulpher %
36-72-0+ 00 kg S ha^{-1}	3.95 ± 0.02 b	1.97 ± 0.01 b	0.24 ±0.07 c
36-72-0+ 20 kg S ha^{-1}	4.4 ± 0.20 ab	2.20 ± 0.10 ab	0.39 ± 0.18 bc
36-72-0+ 40 kg S ha^{-1}	5.25 ± 0.43 a	2.62 ± 0.22 a	0.57 ± 0.06 abc
36-72-0+ 60 kg S ha^{-1}	4.49 ± 0.01 ab	2.24 ± 0.01 ab	0.75 ± 0.07 ab
36-72-0+ 80 kg S ha^{-1}	4.15 ± 0.08 b	2.07 ± 0.04 b	0.89 ± 0.07 a
SE	0.0214	0.005	0.005
LSD 5%	0.0637	0.014	0.014

Each value is a mean ± SE of three replicates; Different letters in a column represent significant difference among treatments ($P \leq 0.05$) as a function of nitrogen, phosophorous and sulphur application.

CONCLUSION

The growth and yield indicators (emergence, plant height, branches numbers, seed index, grain yield and number of pods plant^{-1}) significantly increased with the increasing rates of sulphur. Among the studied, the sulphur @ 40 kg S ha^{-1} produced notable influence on defined parameters as compared to other S levels. From the obtained results of the experiment, it is recommended that for better chickpea growth and yield sulphur application @ 40 kg ha^{-1} should be applied along with recommended NPK (36-72-0) grown under rice chickpea cropping system.

REFERENCES

Alukh, M. S., & Pasricha N. S. (2017). Interaction effect of P and S on the growth and nutrient uptake of mung. Pl. So., **17** (2): 341.345.

Andrieu, N., K. Descheemaeker, T. Sanou, E. Chia. (2015). Effects of technical interventions on flexibility of farming systems in Burkina Faso: Lessons for the design of innovations in West Africa. Agr Syst **136**, 125-137.

Annonymous. 2011. Agricultural Statistics of Pakistan 2009–10. Ministry of Food Agriculture and Livestock, Economic Wing, Islamabad.

Duke, S. D., & P. H. Mishra. (1970). Effect of S deficiency on growth, yield and quality of some important leguminous crops. J. Ind. Soc. Soil Sci., **18**: 375-378.

Gomez, K. A., & A. A. Gomez. (1984). Statistical procedures for agricultural research. John Wiley and Sons, Inc. London, UK (2nd edtn). 13-175.

GOP, 2018. Economic Survey of Pakistan. Economic advisor's wing, Finance Division, Islamabad, Pakistan. Islamabad.

Islam, M., S. Ali and R. Hayat. (2009). Effect of integrated application of phosphorus and sulphur on yield and micronutrient uptake by chickpea (*Cicer arietinum*). Int. J. of Agri & Bio., **11** (1), 33-38.

Islam, M., S. Mohsan and S. Ali (2011). Effect of different phosphorus and sulphur levels on nitrogen fixation and uptake by chickpea (*Cicer arietinum* L.). Agrociencia, **46**: 1–13.

Islam, M., S. Mohsan, S. Ali, R. Khalid, H. Fayaz, A. Mahmood and A. Subhani. (2012). Growth, Nitrogen fixation and nutrient uptake by Chickpea (*Cicer arietinum*) in response to phosphorus and sulfur application under rainfed conditions in Pakistan. Int. J. of Agri & Bio., **13** (5) 71-76.

Khalid, K., K. S. Khan, G. Shabbir, M. Yousaf and S. Y. Naz. (2009). Status of plant available sulfur and its relationship to other soil characteristics in pothwar soils. Pakistan J. Sci. Ind. Res., **52**: 84–90.

Muhammad, I., R. Islam and S. Ali. (2016). Effect of integrated application of sulphur and phosphorus on nitrogen fixation and nutrient uptake by chickpea (*Cicer arietinum* L.). J. Agric. Sci., **35** (2): 154-162.

Nawange, D. D., A. S. Yadav and R. V. Singh. (2011). Effect of phosphorus and sulphur application on growth, yield attributes and yield of chickpea (Cicer *arietinum* L). J. Agric. Sci., **34** (1): 50-55.

Omar, Z. K., N. Asad, M. Shahbaz, S. Akhtar, M. Faisal, K. Mushtaq. (2017). Assessing the factors affecting the yield of Chickpea in Thal Punjab, Pakistan. J. Innov. Bio. Res. **1**(1): 46-51.

Patel, H. K., P. M. Patel and M. R. Patel. (2012). Effect of sulphur and phosphorus management on growth and yield of chickpea. J. Pl. Sci., **66** (2): 664-672.

Saito, K. (2004). Sulphur assimilatory metabolism. Pl. Phy., **136**: 2443–2450.

Sexton, P. J., N. C. Paek and R, Shibles. (1998). Soybean sulphur and nitrogen balance under varying levels of available sulphur. Crop Sci., **37**: 1801-1806.

Taalab A.S., F.A. Hellal and M. A. Abou-Seeda. (2008). Influence of phosphatic fertilizers enriched with sulfur on phosphorus availability and corn yield in calcareous soil in arid region. Ozean J. Applied Sci., **1:** 105–115.