Original Research Article

"Effect of Phosphorus and Iron on Growth and Yield of Chickpea (*Cicer arietinum var. kabulium*)"

ABSTRACT

The field experiment was conducted "Effect of Phosphorus and Iron on growth and yield of Chickpea (*var. NBeG-119*) during *Rabi season*, 2021-22 with 9 treatments (viz., Phosphorus at 30,40 and 50 kg/ha respectively and Iron at 3,5 and 7 kg/ha respectively) at the CRF (Crop Research Farm) Department of Agronomy, Sam Higginbottom University of Agriculture,Technology And Science,Prayagraj, Uttar Pradesh, India. The treatment compared T1- Phosphorus 30 kg/ha + Iron 3kg/ha, T2- Phosphorus 30 kg/ha + Iron 5kg/ha, T3- Phosphorus 30 kg/ha + Iron 7kg/ha, T4- Phosphorus 40 kg/ha + Iron 3kg/ha, T5- Phosphorus 40 kg/ha + Iron 5kg/ha, T6- Phosphorus 40 kg/ha + Iron 7kg/ha, T7- Phosphorus 50 kg/ha + Iron 3kg/ha, T8- Phosphorus 50 kg/ha + Iron 5kg/ha, T9- Phosphorus 50 kg/ha + Iron 7kg/ha. Application of phosphorus 40 kg/ha + Iron 5kg/ha recorded highest plant height (69.10 cm), plant dry weight (25.00 g/plant) number of branches per plant (2.33), number of nodules/plant (21.32), plant dry weight (25.00 g/plant) number of seeds/pod (1.93), seed index (309.83 g), seed yield (2.60 t/ha) stover yield (4.23 t/ha) Harvest index (38.08%) highest gross returns (156000.00 INR/ha) net returns (109340.00 INR/ha) and benefit cost ratio (2.34)

Keywords*: *Economics, Growth parameter, chickpea, phosphorus,iron, yield parameter.

INTRODUCTION

Being a cheapest source of proteins, pulses are often refered as poor man's meat in developing countries. pulses from an integral part of farming system and vegetarian diet in Indian sub-continent. Besides being a rich source of protein, they maintain soil fertility through biological nitrogen fixation and thus play a vital role in furthering sustainable agriculture. Chickpea (Cicer arietinum) is the second important pulse crops that belongs to the legume family. The crop is mainly produced for human consumption, animal feed and as a rotational crop with cereal. Chickpea is one of the health foods that provide cheap but high-quality protein especially for those developing countries that can't afford high price for animal protein.

Pulse production in India is about 25.72 million tons with area under cultivation of around 288.3 lakh hectares and pulse production in Uttar Pradesh is 2.62 million tones with area under cultivation of around 0.81 lakh hectares (GOI,2021). In India chickpea had a lion share of 49.3 % in total pulse production (ICRISAT, 2021), significantly its importance in Indian agricultural production. Worldwide 14,246,295 tons of chickpea produced per year from India produces alone more than 60% of worlds chickpea (Atlas big).

Chickpea (Cicer arietinum var. kabulium.) is one of the foremost rabi pulse crop which as high digestible dietary protein (17-21%). Chick pea is also rich in calcium, Iron, niacin,Vitamin C and B. Its levels contain maleic acid which is very useful for stomach ailments and blood purification. Phosphorus deficiency in the soil is one of the major constraints for low productivity of chickpea (Singh and Bajpal 1982). About 80-90 per cent of total nitogen requirement of chickpea is met through biological nitrogen fixation. Phosphorus fertilization is important for chickpea, Having very specific key-role in biological nitrogen fixation.It improves root development and nodulation. Although information is available on the P level in desi chickpea, the information on the response of kabuli chickpea to phosphorus is rather limited.

Iron is the most important micronutrient for chickpea crop. Fe is present at high quantities in soils but its availability to plants is usually low and therefore Fe deficiency is common problem (Nozoye et al.,2011). Iron plays an important role in synthesis and maintenance of chlorophyll in plant. It helps in the formation of chlorophyll and it is an important constituent of the enzyme nitrogenase, which is essential for nitrogen fixation (Yadav et al.,002). It has an essential role in nucleic acid metabolism. It activates number of enzymes, including amino linolenic acid synthetase and coproporphyrinogen oxidase and a structural component of hemes. hematin and leg hemoglobin (Kumar et al., 2009). Iron is a constituent of two groups of protein, viz. (a) Heme protein contain Fe porphyrin complex as a prosthetic group: cytochrome oxidase, catalase, peroxidase, leg hemoglobin and (b) Fe-S protein in which Fe is coordinated to the thiol group of cysteine or to inorganic ferredoxin. Iron helps in electron transport coupled with oxidative phosphorylation during respiration. The iron, being a constituent of ferredoxin cytochromes is involved in respiration linked active uptake of irons. It being a constituent of ferredoxin also plays a key role in nitrogen fixation by diverse group of micro-organisms-aerobic and anaerobic bacteria and blue green algae. It helps in absorption of other nutrients. A deficiency of iron causes chlorosis between the veins of leaves. A little amount of Fe enhanced the chickpea yield and quality, Application of Fe fertilizer for crop production also reduces the malnourishment in human and animals. Iron deficiency is one of the major limiting factors affecting crop yields. Therefore, approaches need to be developed to increase Fe uptake by roots, transfer to edible plant portions and absorption by humans from plant food sources. Application of Fe fertilizers in chickpea crop production may be a better sustainable option to overcome these problems in the future.
Therefore, a study was envisaged to find out the “Effect of phosphorus and iron on growth and yield of chickpea (Cicer arietinum var. kabulium)

MATERIALS AND METHODS

The experiment was carried out during *Rabi*, 2021-22 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P) which is located at 25^{o}39”42” N latitude, 81^{o}67”56” E longitude, and 98m altitude above the mean sea level (MSL). This area is situated on the right side of the river Yamuna and by the opposite side of Prayagraj City. All the facilities required for crop cultivation were available. The soil was sandy loam in texture, low in organic carbon and medium in available nitrogen, phosphorus, and low in potassium. Nutrient sources were urea, and Murate of potash to fulfill the requirement of nitrogen, and Potassium. The phosphorus was applied in 30, 40, and 50 kg/ha. The crop was sown on 01^{st} November 2021. The experiment was laid out in Randomized Block Design with nine treatments each replicated thrice viz., T1- Phosphorus 30 kg/ha + Iron 3kg/ha, T2- Phosphorus 30 kg/ha + Iron 5kg/ha, T3- Phosphorus 30 kg/ha + Iron 7kg/ha, T4- Phosphorus 40 kg/ha + Iron 3kg/ha, T5- Phosphorus 40 kg/ha + Iron 5kg/ha, T6- Phosphorus 40 kg/ha + Iron 7kg/ha, T7- Phosphorus 50 kg/ha + Iron 3kg/ha, T8- Phosphorus 50 kg/ha + Iron 5kg/ha, T9- Phosphorus 50 kg/ha + Iron 7kg/ha.Blanket application of a recommended dose of Nitrogen and Potassium (20:0:20 NPK kg/ha). phosphorus levels are (30,40,50kg/ha) and Iron levels are(3,5,7kg/ha) was applied as soil application along with blancket application of fertilizers before sowing. The growth parameters reading such as plant height, number of branches per plant, number of nodules per plant, plant dry weight and also, yield parameters such as number of pods per plant, number of seeds per pod, seed index, seed yield, and harvest index. These parameters were recorded and statistically analyzed using analysis of variance (ANOVA) as applicable to Randomized Block Design.

RESULTS AND DISCUSSION

Effect of Phosphorus and Iron on Growth and Yield of Chickpea table 1.

Plant height

At harvest, significantly maximum plant height (69.10) was recorded in treatment 5(40 Kg/ha Phosphorus + 5 Kg/ha Iron). However, the treatment-6 (phosphours 50 kg/ha + iron 7 kg/ha) (68.67 cm) were found to be statistically at par with treatment-5. The increase in growth of plants under phosphorus treatment (40kg/ha) may be due to the stimulating effect of phosphorus on plant process as phosphorus is a major constituent of plant cell nucleus and growing root tips which help in cell division and root elongation which results in vigorous growth of plants and extension root system leading to increase in growth parameters. Similar findings were observed by **Choudhary and Goswami (2005), Kumar et al., (2009) and K.K. Pingoliya.**

Number of branches/plant

At Harvest, Significantly higher number of branches/plant (21.32) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron). However, the treatment-6 (phosphours 50 kg/ha + iron 7 kg/ha) (20.80) Increase in number of branches/ plants was with the application of Phosphorus (40 kg/ha). This might be due to the fact that phosphorus being an energy essential for almost all metabolic processes, photosynthesis, respiration, cell elongation and cell division, activation of amino acids for synthesis protein and carbohydrate metabolism which ultimately increase all the growth attributes and dry weight of plants. Similar results have also been recorded by **Saraf et al., (1997); Singh et al., (2010);**

Number of nodules/plant

At Harvest, Significantly higher number of nodules/plant (2.33) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron). However, the treatment-6 (phosphours 50 kg/ha + iron 7 kg/ha) (2.07 cm). The increase in number of nodules/ plant with the application of Iron (5Kg/ha) which might have stimulated the metabolic and enzymatic activities thereby increasing the growth of the crop. Similar findings were also reported by **Trivedi et al., (2011)., Kuldeep et al.,**

Dry matter accumulation

At Harvest, Significant and higher plant dry weight (25.00 g/plant) was recorded in thetreatment 5(40 Phosphorus + 5 Kg/ha Iron). However, the treatment-6 (phosphours 50 kg/ha + iron 7 kg/ha) (24.47g/plant). Increase in plant dry weight was

With the application of Phosphorus (40Kg/ha) being an energy bond compound and its major role is transformation of energy essential for almost all metabolic processes photosynthesis, respiration, cell elongation and cell division, activation of amino acids for synthesis of protein and carbohydrate metabolism which ultimately increase all the growth attributes and dry weight of plants. Similar results have been reported by **Saraf et al.(1997),Singh et at.(2010).**

Yeild parameters

Effect of Phosphorus and Iron on Growth and Yield of Chickpea table 2

Pods/plant

At Harvest, Significant and higher number of nodules (45.07) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron) over all the treatments. Whereas treatment1-1 (30 Phosphorus + 3Kg/ha Iron)was found the lowest.. The increase in seeds/pods per plant might be due to more availability of phosphorus to plant at all growth stages. Similar finding was reported by **Tisdale et al, (1985).**

Seeds/plant

At Harvest, Significant and higher number of nodules (1.93) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron). Whereas treatment1-1 (30 Phosphorus + 3Kg/ha Iron) (1.00) was found the lowest. This might be due to more availability of Phosphorus to enhance the crop yield. Similar findings were reported by **Sharma et al., (2008); K. K. Pingoliya; M.L. Dotaniya., (2014)**

Seed index

At Harvest, Significant and higher seed index (309.83) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron). Whereas treatment1-1 (30 Phosphorus + 3Kg/ha Iron) (269.20) was found the lowest.

Seed yield

At Harvest, Significant and higher seed yield (2.60 t/ha) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron). Whereas treatment1-1 (30 Phosphorus + 3Kg/ha Iron) (2.20 t/ha) was found the lowest. Increase in seed yield was with the application of iron (5Kg/ha) plays important role in synthesis of chlorophyll and growth regulator and also improves photosynthesis and assimilates transportation to sink and finally increase seed yield. Similar results were observed by **Mali et al., (2003) and Jin et al., (2008); Kumar et al (2019)**

Stover yield

At Harvest, Significant and higher stover yield (2.60 t/ha) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron). Whereas treatment1-1 (30 Phosphorus + 3Kg/ha Iron) (2.20 t/ha) was found the lowest. Increase in stover yield was with application of phosphorus (40kg/ha) played a vital role in physiological and development processes that in result increased straw yield of the crop. Similar findings are also observed by **Singh et al., (1995); Abdul basir., (2008)**

Harvest index

At Harvest, Significant and higher harvest index (38.08) was recorded in the treatment 5(40 Phosphorus + 5 Kg/ha Iron). Whereas treatment1-1 (30 Phosphorus + 3Kg/ha Iron) (35.22) was found the lowest. Higher harvest index was observed due to improved cell activities, enhanced cell multiplication and enlargement and luxuriant growth and yield attributes of the crops probably due to more absorption and utilization of available nutrients leading to overall improvement of crop growth. This is due to application of Iron (5 kg/ha). Similar results also reported by Balai et al. (2017), Kuldeep (2016) Karanjanagi (2013).

Economics

Gross return

Maximum Gross Returns (INR 1,56,000.00) was observed with treatment-5 (40Kg/ha Phosphorus + 5Kg/ha Iron) and the minimum gross returns (INR 1,32,000.00 Rs) was observed with treatment-1 (30Kg/ha Phosphorus + 3Kg/ha Iron) as compared to other treatments.

Net return

Maximum Net Returns (INR 1,09,340.0 Rs) was observed with treatment-5 (40Kg/ha Phosphorus + 5Kg/ha Iron) and the minimum Net returns (INR 86,015.00) was observed with treatment (30Kg/ha Phosphorus + 3Kg/ha Iron) as compared to other treatments.

B:C Ratio

Maximum B:C Ratio (2.34) was observed with treatment 5(40Kg/ha Phosphorus + 5Kg/ha Iron) and the minimum B:C Ratio (1.87) was observed with treatment (30Kg/ha Phosphorus + 3Kg/ha Iron) as compared to others. Highest Benefit cost ratio was recorded with the application of 40 kg/ha phosphorus+5 kg/ha Iron. Similar findings are also recorded by Devendra Singh and Harendra Singh (2012); sree et al (2020).

Table 1. Effect of Phosphorous and Iron on growth of Chickpea

Treatment combination	**At Harvest**			
	Plant height (cm)	**Number of branches/ plant**	**Number of nodules/ plant**	**Plant dry weight (g)**
1	67.67	18.98	1.40	21.60
2	68.17	19.14	1.60	22.60
3	67.83	19.07	1.47	21.90
4	68.27	19.26	1.67	22.90
5	69.10	21.32	2.33	25.00
6	68.67	20.80	2.07	24.47
7	68.33	19.73	1.73	23.20
8	68.87	20.93	2.27	24.73
9	68.43	20.00	1.93	23.80
F-test	**S**	**S**	**S**	**S**
SEm(±)	0.21	0.25	0.12	0.25
CD 5%	0.64	0.74	0.35	0.76

Table 2. Effect of Phosphorous and Iron on yield of Chickpea

Treatment combination	At Harvest				
	Number of pods/ plant	Number of seeds/ pod	Seed index (g)	Seed yield (t/ha)	Harvest index (%)
1	34.73	1.00	269.20	2.20	35.22
2	39.33	1.13	286.20	2.29	35.94
3	37.07	1.07	279.50	2.23	35.46
4	39.73	1.20	290.60	2.32	36.13
5	45.07	1.93	309.83	2.60	38.08
6	44.13	1.60	302.27	2.51	37.77
7	41.40	1.27	291.80	2.35	36.34
8	44.73	1.67	307.77	2.56	37.80
9	42.07	1.33	295.87	2.47	37.10
F-test	**S**	**S**	**S**	**S**	**S**
SEm(±)	0.52	0.12	0.88	0.03	0.39
CD 5%	1.55	0.36	2.63	0.10	1.16

CONCLUSION

It was concluded that application of phosphorus and Iron performs positively and Improves the growth parameters and yield attributes of chickpea. Maximum grain yield Dry weight, stover yield, gross return and benefit cost ratio was recorded with the application of 40 Kg/ha Phosphorus with 5 kg/ha Iron which may be more preferable for farmers since it is economically more profitable and hence, can be recommended to the farmers.

REFERENCES

Ali, M., and S. Kumar. 2005. Pules-Yet to see a break through. *The Hindu Survey.*

Anil Kumar, Reena, Brij Nanadan, Jai Kumar and Jamwal BS. Effect of phosphorous and seed rate on growth and productivity of large seeded kabuli chickpea (Cicerarietinum L.) in subtropical kandi areas of Jammu and Kashmir. Journal of Food legumes 2008;21(4): 231- 233.

Gomez, K.A., and A.A. Gomez. Statistical procedures for agricultural research. John Wiley and Sons, New York, 1984;680p.

Jat,R.S., Ahalawat,I.P.S. (2004). Effect of vermicompost, biofertilizer and nutrient uptake by gram (*Cicer arietinum*) and their residual effect on fodder maize (*Zea mays*). *Indian Journal Agricultural Sciences***74**:359-61.

Kuldeep, Kumawat,P.D., Bhadu,V., Sumeriya,H.K., Kumar,V. (2018) Effect of Iron and Zinc Nutrition on Growth Attributes and Yield of Chickpea (*Cicer arietinum* L.) *International Journal of Current Microbiology and Applied Sciences 7(8).*

Kumar,S.H., Dawson,J., Kiran,P.S., Vyas,V.V. (2020) Effect of Iron and Zinc Levels on Growth and Yield of Chickpea (*Cicer arietinum* L.) *International Journal of Current Microbiology and Applied Sciences* ***9***(11): 2882-2886

Kumar,V., Dwivedi,V.N., Tiwari,D.D. (2009). Effect of phosphorus and iron on yield and mineral nutrition in chickpea. *Annals Plant Soil Research.* **11**:16-18.

Nozoye, T., Nagasaka, S., Kobayashi, T., Takahashi, M., Sato, Y., *et al.*, 2011. Phytosiderophore efflux transporters are crucial for iron acquisition in graminaceous plants. *J. Biol. Chem.* 286, 5446-5454. Doi: 10.1074/jbc.M110.180026.

Pingoliya,K.K., Dotaniya,M.L., Lata,M. (2014) Effect of iron on yield, quality and nutrient uptake of chickpea (*Cicer arietinum*) *African Journal of Agricultural Research* **9**(37): 2841-2845.

Pirdadeh,H., Hamidian,K., Tahamasebi,J., Rafee,M. (2013) Effect of Fe on Yield and Other Cultural Traits of Chickpea *Asian journal of experimental biological sciences* **4**(2):256-259.

Pramanik,K., Singh,R.K. (2003). Effect of levels and mode of phosphorus and biofertilizers on chickpea under dryland conditions *Indian. Journal of Agronomy.* **48**:294-296.

Pyare, R., Dwivedi, D.P. 2005. Yield, economics and quality of chickpea (*Cicer arietinum* L.) as affected by row spacing and phosphorus under limited irrigation. *CropRes. Hisar.* **29**(1): 95-100.

Sharma,V., Abrol,V. (2007). Effect of phosphorus and zinc application on yield and uptake of phosphorus and zinc by chickpea under rainfed conditions. *Journal Food Legumes* **20**:49-51.

Singh, G. and Bajpai, M.R. 1982. Response of Chickpea to Phosphorus and Foliar application of Zinc and Sulfuric acid. *Indian Journal of Agricultural Sciences.* **52**(12): 835-837.

Singh,O.N., Sharma,M., Dash,R. (2003). Effect of seed rate, phosphorus and FYM application on growth and yield of bold seeded lentil. *Indian Journal Pulse Research.* **16**:116-118.

Yadav, R.K., Goyal, B., Sharma, R.K., Dubey, S.K and Minhas, P.S. 2002. Post- irrigation impact of domestic sewage wastewater on composition of soils, crops and ground water-a case study. *Environmental International,* **28**, 481-48