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Effect of phosphorus and iron levels on growth and economics of Chickpea (*Cicer arietinum* L.)

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Abstract
The investigation was carried out to study in *rabi* 2019 to study the effect of Phosphorus and Iron on growth and yield of chickpea (*Cicer arietinum* L.). The experiment consists of nine treatments replicated thrice laid out in Randomized Block Design. The treatment consisted of micronutrients *viz.* Phosphorus at 20 kg/ha, 40 kg/ha and 60 kg/ha and Iron 2 kg/ha, 4 kg/ha and 6 kg/ha whose effect is observed on Chickpea. Among the treatments it was observed that the treatment with application of 60 kg/ha Phosphorus + 6 kg/ha Iron was found to be the best treatment for obtaining growth and economics. Growth parameters such as plant height (70.71 cm), plant dry matter (24.49 g/plant) found to be maximum in treatment combination 60 kg/ha Phosphorus + 6 kg/ha Iron, crop growth rate (13.53 g/m2/day) and relative growth rate (0.021 g/g/day) found to be maximum in treatment combination 40 kg/ha Phosphorus + 2 kg/ha Iron. Economics *viz*., gross return (INR 128836.20/ha), net return (INR 82071.20), B:C ratio (1.75), was also recorded higher with the application of 60 kg/ha Phosphorus + 6 kg/ha Iron. Therefore, application of 60 kg/ha Phosphorus + 6 kg/ha Iron was more productive and economically feasible.

Keywords: Phosphorus, iron, chickpea, growth, yield and B:C ratio

Introduction
Chickpea (*Cicer arietinum* L.), the premier pulse crop of India, popularly known as Gram or Bengal gram is mainly grown in *Rabi* season. It is the member of the family Leguminaceae and sub family Papilionaceae. Phosphorus is known to play beneficial role in legume growth by promoting extensive root development and nodulation (Sarawgi *et al*., 1999) [7]. Phosphorus application to legumes plays a key role in the formation of energy rich phosphate bonds, phospholipids and for development of root system (Tisdale *et al*. 1999). Iron plays a crucial role in redox system in cell and various enzymes. Dicotyledonous and grami–neaceous plants have different strategies to acquire Iron (Marschner, 2012) [6]. The growth and yield data indicates that the application of Fe singly or in combination with other element in various groups increased pod bearing, branching, test weight, total dry weight, pods and yield of chickpea. Keeping the above facts in view the present investigation was undertaken to study the effect of Phosphorus and Iron levels of growth and yield of chickpea (*Cicer arietinum* L.) during *rabi* 2019.

Materials and Methods
For the intended study, nine treatments were tested under three replications and laid out in randomized block design. Phosphorus *viz.* 20 kg/ha, 40 kg/ha and 60 kg/ha and Iron 2 kg/ha, 4 kg/ha and 6 kg/ha. The soil of the experimental field was sandy loam in texture, slightly alkaline reaction (pH 7.5) with low level of organic carbon (0.34%), available P (19.5 kg/ha) and higher level of K (92 kg/ha). At initial stage select random five plants from net plot area for further recording observations at 20 days sequence. The crop management practices were similar in all treatments but there is a difference in fertilizer application to each treatment. Application of Phosphorus and Iron were applied as basal application at the time of sowing as per treatments. The treatment combinations are T 1- Phosphorus 20 kg/ha + Iron 2 kg/ha, T 2- Phosphorus 20 kg/ha + Iron 4 kg/ha, T 3- Phosphorus 20 kg/ha + Iron 6 kg/ha, T 4- Phosphorus 40 kg/ha + Iron 2 kg/ha, T 5- Phosphorus 40 kg/ha + Iron 4

kg/ha, T 6- Phosphorus 40 kg/ha + Iron 6 kg/ha, T7- Phosphorus 60 kg/ha + Iron 2 kg/ha, T 8- Phosphorus 60 kg/ha + Iron 4 kg/ha, T 9- Phosphorus 60 kg/ha + Iron 6 kg/ha. Hand weeding was done after 25 & 45 DAS. Two irrigations were given, one at pre-flowering and one at before pod formation stage. Nipping has done at about 30-40 days after sowing and it promotes the lateral branching, thus the plants become more vigorous and produce more flowers, pods and yield per plant increases. The observations were recorded on different growth parameters at 120 DAS *viz*. plant height(cm), dry weight (g), crop growth rate (g/m2/day), relative growth rate (g/g/day), Economics *viz*. gross return, net return, B:C ratio. Spacing maintained was 30×10 cm.

Results and Discussion

A. Growth Parameters: Plant height (cm)

The plant height at 120 DAS, significant and maximum (70.71 cm) was observed in treatment combination 60 kg/ha Phosphorus + 6 kg/ha Iron were recorded as compared to other treatments. However, on par with the treatment combination with 20 kg/ha Phosphorus + 6 kg/ha Iron (69.35 cm). The plant height was increased with the application of Phosphorus, due to the fact that the phosphorus is a vital component structure of ATP during photosynthesis. Phosphorus plays a major role from the beginning of seedling growth throu+gh to the formation of maturity and grain. Thus, it is essential for the general growth and vigor of the plants. These results are consistent with that achieved from Dotaniya *et al*., (2013). The increase in the availability of Iron to plant might have stimulated the metabolic and enzymatic activities thereby increasing the growth of the crop Trivedi *et al*., (2011) [9].

Plant dry matter (g)

At 120 DAS, Treatment with the application of 60 kg/ha Phosphorus + 6 kg/ha Iron was shown significantly maximum plant dry weight which is of (24.49 g), however treatments with combinations of 40 kg/ha Phosphorus + 2 kg/ha Iron (24.48 g), was on par with the treatment combination 60 kg/ha Phosphorus + 6 kg/ha Iron. The total dry matter production depends upon photosynthesis ability of a plant which in turn depends on the dry matter accumulation in leaves, dry matter accumulation per plant were significantly higher with increasing levels of Phosphorus in chickpea Arya *et al*., (2002) [2]. Increasing levels of Iron significantly increased the dry matter accumulation Kuldeep *et al*., (2018) [5].

Crop growth rate (g/m2/day)

At 100-120 DAS, Treatment with the application of 40 kg/ha Phosphorus + 2 kg/ha Iron was shown significantly maximum crop growth rate which is of (13.53 g/m2/day), however treatments with combinations of 20 kg/ha Phosphorus + 6 kg/ha Iron (11.35 g/m2/day) and 40 kg/ha Phosphorus + 6 kg/ha Iron (9.37 g/m2/day) was on par with the treatment combination 40 kg/ha Phosphorus + 2 kg/ha Iron. The increase in the availability of Iron might have stimulate the metabolic activity by enhancing the chlorophyll component in leaves which leads to accumulation plays a crucial role in crop growth rate. Alam and Haider (2006) [1] and Kibe *et al*., (2006).

Relative growth rate (g/g/day)

At 100-120 DAS, Treatment combination with the application of 40 kg/ha Phosphorus + 2 kg/ha Iron was shown significantly maximum relative growth rate which is of (0.021 g/g/day), however treatments with combinations of 20 kg/ha Phosphorus + 6 kg/ha Iron (0.020 g/g/day) and 40 kg/ha Phosphorus + 6 kg/ha Iron (0.016 g/g/day) was on par with the treatment combination 40 kg/ha Phosphorus + 2 kg/ha Iron. These results are similar with Alam and Haider (2006) [1] and Kibe *et al*., (2006).

B. Economics

Cost of cultivation, Gross Return, Net Return and B: C Ratio

The cost of cultivation of chickpea crop recorded numerically higher (Rs 45325/ha) value for the treatment of application of 60 kg/ha Phosphorus + 6 kg/ha Iron. Numerically minimum cost of cultivation was recorded with application of treatment combination of 20 kg/ha Phosphorus + 2 kg/ha Iron (Rs 41085/ha) in treatment.

Maximum gross return was recorded with application of 60 kg/ha Phosphorus +6 kg/ha Iron (Rs.128836.20/ha) which was highest overall the treatments, minimum gross return was recorded with the application of 60 kg/ha Phosphorus + 4 kg/ha Iron (Rs.124295.5/ha).

Numerically higher net return was recorded with application of 60 kg/ha Phosphorus + 6 kg/ha Iron (Rs.82071.20/ha) which was highest over all the treatments, minimum net return was recorded with application of treatment combination 20 kg/ha Phosphorous + 2 kg/ha Iron (Rs.66356.68/ha).

Highest Benefit Cost ratio was recorded with application of 60 kg/ha Phosphorus + 6 kg/ha Iron (1.75) which was superior over all the treatments however, the minimum B:C ratio was recorded with application of 40 kg/ha Phosphorus + 6 kg/ha Iron (1.51). These findings are similar with Devendra Singh and Harendra Singh (2012) [3].

Table 1: Growth Attributes of chickpea as influenced by application of Phosphorus and Iron at harvest

Treatments	Plant height (cm)	Plant dry matter (g/plant)	Crop Growth Rate (g/m2/day)	Relative Growth Rate (g/g/day)
T_1 20 kg/ha Phosphorus + 2 kg/ha Iron	67.67	18.99	6.377	0.011
T_2 20 kg/ha Phosphorus + 4 kg/ha Iron	68.20	20.36	5.605	0.009
T_3 20 kg/ha Phosphorus + 6 kg/ha Iron	69.35	19.84	11.355	0.020
T_4 40 kg/ha Phosphorus + 2 kg/ha Iron	67.43	24.48	13.533	0.021
T_5 40 kg/ha Phosphorus + 4 kg/ha Iron	68.26	20.36	7.544	0.012
T_6 40 kg/ha Phosphorus + 6 kg/ha Iron	68.35	20.62	9.372	0.016
T_7 60 kg/ha Phosphorus + 2 kg/ha Iron	67.50	21.50	5.166	0.007
T_8 60 kg/ha Phosphorus + 4 kg/ha Iron	66.50	20.51	6.750	0.011
T_9 60 kg/ha Phosphorus + 6 kg/ha Iron	70.71	24.49	5.827	0.007
S.Em(±) CD (p=0.05)	0.54	0.60	1.396	0.002
	1.63	1.80	4.186	0.007

Table 2: Economics of chickpea as influenced by application of Phosphorus and Iron.

Treatments	Total cost of Cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
T_1 20 kg/ha Phosphorus + 2 kg/ha Iron	41085	107921.70	66356.68	1.60
T_2 20 kg/ha Phosphorus + 4 kg/ha Iron	41205	108229.70	66064.68	1.57
T_3 20 kg/ha Phosphorus + 6 kg/ha Irons	41325	109911.60	67146.61	1.57
T_4 40 kg/ha Phosphorus + 2 kg/ha Iron	43085	110220.30	66655.27	1.53
T_5 40 kg/ha Phosphorus + 4 kg/ha Iron	43205	115255.70	71090.70	1.61
T_6 40 kg/ha Phosphorus + 6 kg/ha Iron	43325	112285.80	67520.80	1.51
T_7 60 kg/ha Phosphorus + 2 kg/ha Iron	45085	121780.60	76215.56	1.67
T_8 60 kg/ha Phosphorus + 4 kg/ha Iron	45205	118129.00	71964.03	1.56
T_9 60 kg/ha Phosphorus + 6 kg/ha Iron	45325	128836.20	82071.20	1.75

Conclusion

From the experimental findings, it can be concluded that for obtaining higher yield components with better quality of chickpea (Pusa 362) has fertilized with the application of Phosphorus 60 kg/ha and Iron 6 kg/ha was found more growth effective and as well as economic (Rs. 82071.20/ha) and maximum B:C ratio recorded (1.75).

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