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Impact of nitrogen and iron on yield attributes and economics of chickpea (*Cicer arietinum* L.)

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Abstract
A field experiment was conducted during *Rabi* season 2021 at the experimental field of the Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India which is located at 25^0 30' 42''N latitude, 81^0 60' 56" E longitude, and a height of 98 metres above sea level. The soil of the experimental field in Sandy loam in texture, nearly neutral in soil reaction (PH 7.1), low in organic carbon (0.36%) available N (171.48 kg/ha), available P (27.0 kg/ha) and K (291.2 kg/ha). The Experiment was laid out in Randomized Block Design with Nine treatments replicated thrice based on one year of experimentation. To determine the "Effect of Nitrogen and Iron on Yield attributes and economics of Chickpea (*Cicer arietinum* L.)". The treatments consisted of three levels of Nitrogen – 15, 20 and 25 kg/ha and three levels of Iron – 2.5,5, 7.5 kg/ha. The results revealed that treatment with application of Nitrogen at 25 kg/ha + Iron at 7.5 kg/ha recorded significantly highest number of pods per plant (61.2), seeds per pod (3.5), seed index (26.00 g), seed yield (1919.1 kg/ha) and Haulm yield (3186.6 kg/ha), Maximum Gross return (INR 1, 01, 712.30/ha), Net return (INR 69,305.56/ha) and Benefit cost ratio (2.13).

Keywords: Nitrogen, iron, growth, yield and economics

Introduction
Chickpea (*Cicer arietinum* L.) is an important crop for vegetarian people as primary source of protein, it is third most important pulse crop grown in the world after dry beans and peas (Kaur *et al.*, 2020). India ranks first in area and production of chickpea followed by Australia, Pakistan and Turkey. As per 4th advance estimates, it accounts an acreage of 10.17 million hectares contributing 11.35 million tonnes of production with an average productivity of 1,116 kg/ha during 2019-20 in India. Among states, Rajasthan, Madhya Pradesh, Maharashtra, Karnataka, Bihar, Andhra Pradesh, Tamil Nadu and Gujarat are primarily growing states of chickpea. Moreover, it has occupied on 2.46 million hectares with a production of 2.66 million tonnes and productivity of 1,080 kg/ha in Rajasthan (DES, 2020) [1]. This crop is tolerant to drought, can be grown successfully on well drained loamy to sandy loam soils under residual moisture (Yadav *et al.*, 2019) [11].

Nitrogen is required for both vegetative and reproductive growth of a crop. It is primarily applied to agricultural crops through the soil. Foliar nitrogen administration, on the other hand, effectively boosts both vegetative and reproductive growth. Photosynthates are used for root nodule formation and function during early development of grain legumes, but as flowering begins, the developing seeds require higher nitrogen levels. As a result, leaf nitrogen is redirected to grain filling, resulting in blossom shedding and a poor sink realization. Nitrogen added during flowering boosts pod setting and production.

Iron (Fe) plays an important role in chlorophyll synthesis and act as structural component of hemes, hematin and leghaemoglobin involved in the nitrogen fixation in pulses catalysed by an enzyme called "nitrogenase" (Larson *et al.*, 2018) [7]. Moreover, iron is the most essential micronutrient for plant growth especially for chickpea grown on saline and alkaline soils (Larson *et al.*, 2015) [6].

Materials and Methods
The experiment carried out during *rabi* season of 2021 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.). which is located at 25^0 30' 42''N latitude, 81^0 60' 56" E longitude, and a height of 98 metres above sea level.The soil texture in the experimental plot was sandy loam, with a practically neutral soil reaction (PH 7.1), low organic carbon (0.44 percent), available N (171.48 kg/ha), available P (27.0 kg/ha),

and available K (291.2 kg/ha) (Jackson, M.L. 1973) [4]. The crop was sown on 28 November 2021 using variety RVG - 202. The experiment was set up in a Randomized Block Design with three replications and nine treatments in total *viz.*, T1: 15kg/ha Nitrogen +2.5kg/ha Iron, T2: 15kg/ha Nitrogen + 5kg/ha Iron, T3: 15kg/ha Nitrogen +7.5kg/ha Iron, T4: 20kg/ha Nitrogen +2.5kg /ha Iron, T520kg/ha Nitrogen + 5kg /ha Iron, T6: 20kg/ha Nitrogen + 7.5kg /ha Iron, T7: 25kg/ha Nitrogen +2.5kg /ha Iron, T8: 25kg/ha Nitrogen + 5kg /ha Iron and T9: 25kg/ha Nitrogen +7.5kg /ha Iron. Recommended dose of fertilizers (P: K) will be supplied in the form of single super phosphate (SSP), and muriate of potash (MOP) as a basal dose in all plots, and the treatments (Nitrogen and Iron) were applied in the form of Urea and Ferrous sulphate according to the treatment levels in as basal doses. The growth Parameters were measured at 20, 40, 60,80 days intervals, as well as at harvest stage, from randomly selected plants in each treatment. The yield attributes were recorded at harvest form randomly selected plants in each plot. A statistical analysis was performed, and the mean was compared at a 5% probability level of significance (Fisher, R.A. and Yates, F. 1963) [3].

Results and Discussion

Effect of Nitrogen and Iron on Yield Attributes of Chickpea.

No. of pods per plant

Treatment with application of 25 kg/ha Nitrogen +7.5kg /ha Iron was recorded number of pods per plant (61.2) which was significantly highest than other treatments and treatment with application of 25 kg/ha Nitrogen +5kg /ha (60.6) which was statistically at par with the treatment with application of 25 kg/ha Nitrogen +7.5kg /ha.

Nitrogen at the vegetative stage enhanced the higher nodulation *i.e.*, produced more number of nodules which were useful during the reproductive stages of the crop (Pod formation and pod filling stages) produced more number of pods per plant. The results were in accordance with those of Dhakad *et al.* (2005) [2], Khan *et al.* (2014) [5], Pingoliya *et al.* (2014) [10], Neeraj *et al.* (2008) [9] and Meena *et al.* (2013) [8].

No. of seeds per pod

Treatment with 25 kg/ha Nitrogen +7.5kg /ha was recorded number of seeds per pod (3.5) which was significantly highest than other treatments and treatment with application of 15 kg/ha Nitrogen +2.5kg /ha (2.9) recorded minimum number of seeds per pod.

Number of seeds per pod was significantly influenced by the application of nitrogen at 25 kg/ha and iron at 7.5 kg/ha due to reduced nutrient deficiencies during crop growth made better pod filling. The results were supported by Dhakad *et al.* (2005) [2] and Khan *et al.* (2014) [5].

Seed index (g)

Treatment 25 kg/ha Nitrogen +7.5kg /ha was recorded seed index (26.0) which was significantly highest than other treatments and treatment with application of 25 kg/ha Nitrogen +5kg /ha (25.6) which was statistically at par with the treatment with application of 25 kg/ha Nitrogen +7.5kg /ha.

An increase in seed index was due to diversion of the flow of photosynthetic assimilates towards the developing seeds are resulted in the seed size in terms of 100 seed weight of treated plants increased over other treatments. Results obtained were similar to Dhakad *et al.* (2005) [2] and Khan *et al.* (2014) [5]

Seed yield (kg/ha)

Treatment with 25 kg/ha Nitrogen +7.5kg /ha was recorded Seed yield (1919.1 kg/ha) which was significantly highest than other treatments and the treatment with application of 25 kg/ha Nitrogen + 5kg /ha (1869.0 kg/ha) which was statistically at par with treatment 25 kg/ha Nitrogen +7.5kg /ha.

Interaction between the Nitrogen and Iron enhanced the better growth and development, higher rate of photosynthesis, better translocation and photosynthates in a good source-sink association, better association of yield attributes *viz.* number of pods per plant, number of seeds per pod and 100-seed weight due to differentiation led to the increased yield in chickpea. The findings were similar to those of Dhakad *et al.* (2005) [2], Khan *et al.* (2014) [5], Pingoliya *et al.* (2014) [10], Neeraj *et al.* (2008) [9] and Meena *et al.* (2013) [8].

Haulm yield (kg/ha)

Treatment with 25 kg/ha Nitrogen +7.5kg /ha was recorded Haulm yield (3186.6 kg/ha) which was significantly highest than other treatments and the treatment with application of 25 kg/ha Nitrogen + 5 kg /ha (3148.7 kg/ha) which was statistically at par with the treatment with application of 25 kg/ha Nitrogen +7.5kg /ha.

Increase in Haulm yield is due to higher dry matter accumulation during the early crop growth stages because of better utilization of nutrients.

Harvest Index (%)

Treatment with 25 kg/ha Nitrogen +7.5kg /ha recorded Harvest index (37.6%) which was significantly highest than other treatments and the treatments with application of 25 kg/ha Nitrogen +5kg /ha (37.2%), 20 kg/ha Nitrogen +7.5kg /ha (37.2%) and 25 kg/ha Nitrogen +7.5kg /ha.

Harvest index is directly correlated to the seed yield and haulm yield. Increased Harvest index was due to better crop growth from early stages to at harvest. Better performance of the crop from vegetative growth to reproductive growth is due to the providing Higher nitrogen and Iron as a basal dose which increased the nutrient uptake of the crop. The results were similar to those of Dhakad *et al.* (2005), Khan *et al.* (2014) [5], Pingoliya *et al.* (2014) [10], Neeraj *et al.* (2008) [9] and Meena *et al.* (2013) [8].

Effect of Nitrogen and Iron on Economics of Chickpea.

Economical Analysis: Gross returns, Net returns and benefit cost ratio of different treatments are depicted in Table 2.

Cost of cultivation (INR/ha)

Cost of cultivation (32,406.70 INR/ha) was found to be highest in 25 kg/ha Nitrogen + 7.5 kg/ha Iron and the minimum cost of cultivation (31,868.10 INR/ha) was found to be in 15 kg/ha Nitrogen + 2.5 kg/ha Iron as compared to other treatments.

Gross returns (INR/ha)

Gross returns (1,01,712.00 INR/ha) were found to be highest in 25 kg/ha Nitrogen + 7.5 kg/ha Iron and the minimum gross returns (69,551.90 INR/ha) was found to be in 15 kg/ha Nitrogen + 2.5 kg/ha Iron as compared to other treatments.

Net returns (INR/ha)

Net returns (69,305.60 INR/ha) were found to be highest in 25 kg/ha Nitrogen + 7.5 kg/ha Iron and the minimum net retunes (37,683.80 INR/ha) was found to be in 15 kg/ha Nitrogen + 2.5 kg/ha Iron as compared to other treatments.

Benefit Cost ratio (B: C)

Benefit Cost ratio (2.13) was found to be highest in 25 kg/ha Nitrogen + 7.5 kg/ha Iron and the minimum benefit cost ratio (1.18) was found to be in with the combined application of 15 kg/ha Nitrogen + 2.5 kg/ha Iron as compared to other treatments.

Table 1: Effect of Nitrogen and Iron on yield attributes of chickpea

S. No.	Treatments	No. of Pods/plant	No. of Seeds/pod	Seed Index (g)	Seed yield (kg/ha)	Haulm yield (kg/ha)	Harvest index (%)
1	15kg/ha Nitrogen +2.5kg/ha Iron	54.8	2.9	24.2	1312.3	2617.9	33.4
2	15kg/ha Nitrogen +5kg/ha Iron	56.4	3.1	25.0	1465.0	2836.1	34.1
3	15kg/ha Nitrogen +7.5kg/ha Iron	56.7	3.1	25.1	1474.1	2903.2	33.7
4	20kg/ha Nitrogen +2.5kg /ha Iron	55.5	2.9	24.7	1382.9	2684.3	34.0
5	20kg/ha Nitrogen +5kg /ha Iron	57.9	3.2	25.2	1573.7	3022.1	34.2
6	20kg/ha Nitrogen +7.5kg /ha Iron	59.0	3.4	25.4	1815.3	3070.4	37.2
7	25 kg/ha Nitrogen +2.5kg /ha Iron	55.7	3.0	24.8	1402.0	2755.7	33.7
8	25 kg/ha Nitrogen +5kg /ha Iron	60.6	3.4	25.6	1869.0	3148.7	37.2
9	25 kg/ha Nitrogen +7.5kg /ha Iron	61.2	3.5	26.0	1919.1	3186.6	37.6
	F test	S	S	S	S	S	S
	S.Em (±)	0.40	0.06	0.20	17.52	34.69	0.33
	CD (P=0.05)	1.20	0.19	0.61	52.52	103.29	1.00

Table 2: Effect of Nitrogen and Iron on economics of chickpea.

S. No	Treatment combinations	Cost of cultivation (INR/ha)	Gross returns (INR/ha)	Net returns (INR/ha)	B: C ratio
1	15kg/ha Nitrogen +2.5kg/ha Iron	31,868.10	69,551.90	37,683.80	1.18
2	15kg/ha Nitrogen +5kg/ha Iron	32,078.80	77,645.00	45,566.20	1.42
3	15kg/ha Nitrogen +7.5kg/ha Iron	32,289.60	78,127.30	45,837.70	1.41
4	20kg/ha Nitrogen +2.5kg /ha Iron	31,297.30	73,293.70	41,996.40	1.34
5	20kg/ha Nitrogen +5kg /ha Iron	32,137.70	83,406.10	51,268.40	1.59
6	20kg/ha Nitrogen +7.5kg /ha Iron	32,348.40	96,210.90	63,862.50	1.97
7	25 kg/ha Nitrogen +2.5kg /ha Iron	31,985.60	74,306.00	42,320.40	1.32
8	25 kg/ha Nitrogen +5kg /ha Iron	32,196.00	99,057.00	66,861.00	2.07
9	25 kg/ha Nitrogen +7.5kg /ha Iron	32,406.70	1,01,712.00	69,305.60	2.13

*Data not subjected to statistical analysis

Conclusion

Based on the research done in one season, it is concluded that for obtaining higher yield in chickpea, application of 25 kg/ha Nitrogen and 7.5kg /ha Iron along with recommended dose of phosphorous and potassium as basal dose is advised as it is recorded maximum number of pods per plant, number of seeds per pod, seed yield, Haulm yield, Gross returns, net returns and Benefit-cost ratio.

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