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Effect of Iron Application and *Rhizobium* Inoculation on Uptake of Nutrients in Grain and Stover of Chickpea (*Cicer arietinum* L.)

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A B S T R A C T

An experiment was conducted in cemented pot in "screen house" of the Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur during Rabi season 2011-2012, to assess the response of inoculation of rhizobium and application of different doses of iron on nutrient uptake in chickpea. Treatments consisted four levels of iron *i.e.* 0, 2.5, 5.0 and 7.5 ppm and two levels of microbial inoculation *i.e.* un-inoculation and inoculation of rhizobium. The treatments were replicated four times in completely randomized design (factorial). The results indicated that among the iron levels, 5.0 ppm showed better expression on uptakeof nitrogen (657.21 mg pot^{-1}, 192.25 mg pot$^{-1,}$), phosphorus (111.40 mg pot^{-1}, 67.48 mg pot^{-1}), iron (1.520 mg pot^{-1}, 2.753 mg pot^{-1}) and consequently recorded significantly higher in comparison to 0, 2.5 and 7.5 ppm levels. The seed treatment of chickpea with rhizobium culture significantly increased the nutrient uptake in grain and stover.

Introduction

Chickpea (*Cicer arietinum* L.) is an important Rabi season pulse crop. It is a major food legume in many countries of Asia, the Middle East and South Central Americas. In India, during 2011-2012, the chickpea crop had production of about 5.89 million tonnes from an area of 7.37 m ha with an average productivity of 799.19 kg ha^{-1}. However, in Uttar Pradesh it is grown in 0.60mha with production of 0.67 million tonnes. The average productivity of Uttar Pradesh is 1120 kg ha^{-1} (India Stat, 2012). Chickpea is grown mostly under rainfed-unirrigated conditions on low fertile soils. Generally, farmers do not apply fertilizers to chickpea crop. Under such conditions due to hungry soil the productivity of this crop is very low notably lower than the average production of this crop in other parts of the world. Therefore, this crop needs to be fertilized to get optimum economic yield.

Iron is the most critical essential micronutrient for plant growth and especially in chickpea grown at saline and alkaline soils. The saline and alkaline soils are deficient in iron which results in the chlorosis of chickpea means lack of chlorophyll which results in the synthesis of photosynthates. In deficiency of iron leaves become unable to synthesise food materials or starch as result plant may fail to complete its life cycle and the pod or grain formation may be affected and the pods remain empty. The application of iron in the form of $FeSO_4$ either in soil or as aerial spray enhance the rate of photosynthesis, which results in the production of higher number of root nodules by providing sufficient food to the bacteria *Rhizobium.* It helps in the conversion of sufficient quantity of atmospheric N to nitrate N and facilitates in the formation of more number of pods, number of grain pod^{-1} and increases seed weight pod^{-1} as a result higher grain yield of chickpeas may be produced. Shukla and Shukla (1994) observed that increase in Fe and P concentration in seeds of chickpea with increasing level of $FeSO_4$ up to 50 kg/ ha over control.

Chickpea obtains a significant proportion of its N requirement through symbiotic N fixation. Inoculation of chickpea with adequate number of rhizobia results in a significant increase in the number of nodules, nodule dry weight and N fixation (Sattar *et al.,* 1993). Growth of chickpea is dependent on nodulation by effective *Rhizobial* strains. Mixed culture inoculation of *Rhizobium* with associate N fixing *Azospirillum sp.* and *Bacillus subtilis* and *PSB megaterium* significantly increased the total number of nodules and dry weight of nodules and consequently the grain weight of chickpea. Management practices to produce larger biomass yields under lower soils nitrate conditions may result in increased N fixation by chickpea (Horn *et al.*, 1996).

The combination of *Rhizobium* culture and iron provides favourable condition in the formation of more number of effective root nodules in which more number of *Rhizobium* bacteria converts more quantity of atmospheric N to nitrate N and increases the soil fertility as a result all the growth and yield attributing components increased significantly. In this regard information available are sporadic and scarce or less work has been done hence a pot experiment project on entitled "Effect of iron and *Rhizobium* application on uptake of nutrients in chickpea" has been undertaken.

Materials and Methods

The experiment was carried out during Rabi season (2011-12) in screen house of the Department of Soil Science and Agricultural Chemistry, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, (U.P.) "to study the effect of iron and *Rhizobium* culture application on nutrient uptake on chickpea". Four levels of iron *viz.*, 0 ppm, 2.5 ppm, 5.0 ppm and 7.5ppm and two levels of bio-fertilizers *viz.*, un-inoculated and inoculation with *Rhizobium*, design in completely randomized design with four replications in cemented pots. *Rhizobium* inoculants were added by seed treatment. Prepared slurry of *Rhizobium* inoculant by adding *Rhizobium* culture (200 g for 10 kg seed) was poured on the seed and mixed with hand to get homogenous coating, thereafter dried in shade and sown the treated seed immediately. The iron was applied as ferrous chloride well mixed in *Rhizobium* and seed inoculation just before the sowing of chickpea crop.

Full dose of phosphorus (40 kg P_2O_5 ha^{-1}) as single super phosphate was applied at the time of sowing. Ten kg well pulverized soil was filled in each cemented pot with polythene inner lining and five seeds were sown in each pot as per treatments on 26th of November, 2011. Recommended cultural operations were adopted. Two plants were maintained in each pot up to the maturity and harvested on 5th April 2012. The representative samples of grain and stover were collected for chemical analysis. Nitrogen content in grain and stover was estimated by micro Khejdahl's method as described by Jackson (1973). For phosphorus content wet digestion method in tri-acid mixture and estimating calorimetrically using ammonium meta-vanadate colouring reagent as described by Chapman and Pratt (1961). The iron content in grain and stover estimated with atomic absorption spectrophotometer. Total nitrogen, phosphorus and iron uptake by grain and stover were calculated by the following formula:

Uptake of nutrient= Percent nutrient × Dry matter yield/100.

Results and Discussion

Nitrogen (N) uptake in grain and stover

It is visualized from the data given in table 1 that iron application and *Rhizobium* inoculation increased the N uptake in grain significantly comparison to control. However, the interaction, I × Fe, showed non-significant effect on N uptake in grain. On an average, the N uptake increased up to the application of 5.0 ppm Fe significantly and thereafter, decreased at 7.5 ppm Fe. The lowest N uptake of 476.97 and highest of 657.21 mg pot^{-1} was recorded at control and 5.0 ppm Fe, respectively. Thus, the highest uptake of N was 37.79 percent higher than the lowest uptake. The highest uptake of 648.24 mg pot^{-1} recorded with *Rhizobium* was computed 24.15 percent higher than the lowest uptake of 522.13 mg pot^{-1} recorded with un-inoculation.

It is obvious from the data given in table 2 that application of iron and seed treatment of *Rhizobium* culture significantly influenced N uptake, while interactions between the treatments were absent. The nitrogen uptake in chickpea increased up to 5.0 ppm Fe and thereafter, decreased at 7.5 ppm Fe. On an average, the N uptake of 192.25 mg pot^{-1} was recorded with 5.0 ppm Fe which was calculated 30.84 per cent higher than the lowest N uptake of 146.93 mg pot^{-1} at control. The highest N uptake 191.04 mg pot^{-1} recorded with inoculation was found 22.25 per cent higher than the N uptake of 156.27 mg pot^{-1} with un-inoculation.

This shows the synergistic effect of iron application on nitrogen and iron concentration in both grain and stover. The increase in iron concentration with its increasing doses is not questionable as iron addition in available form increased its availability to the crop. Increase in nitrogen and iron concentration due to iron application earlier also reported by Mehrotra *et al.*, (1990) and Ghasemi-Fasaei *et al.*, (2007).

Phosphorus (P) uptake in grain and stover

The data on P uptake in grain as influenced by iron application have been given in table 3. At a glance over the table, it is obvious that P uptake in grain increased with an increase in iron level up to 5.0 ppm and thereafter, decreased at 7.5 ppm. On an average, the highest of 111.40 mg pot^{-1}recorded at 5.0 ppm was found 22.61 per cent higher than the lowest P uptake of 90.86 mg pot^{-1} at control *i.e.* no iron application. Likewise iron application, *Rhizobium* inoculation of seeds also exhibited significant positive effect on P uptake in grain. On an average, the P uptake of 121.10 mg pot^{-1} recorded with inoculation was found 45.15 percent higher than the P uptake of 83.43 mg pot^{-1} with un-inoculation. The interaction, I × Fe, did have non-significant effect on P uptake in grain.

It is visualized from the data given in table 4 that iron application enhanced the phosphorus uptake in stover significantly up to 5.0 ppm Fe and thereafter, decreased significantly at 7.5 ppm Fe.

Table.1 Effect of iron and *Rhizobium* on nitrogen uptake (mg pot^{-1}) in grain of chickpea

Treatment	Uninoc.	Inoc.	Mean
0 ppm Fe	435.18	518.75	**476.97**
2.5 ppm Fe	517.08	622.08	**569.58**
5.0 ppm Fe	581.44	732.98	**657.21**
7.5 ppm Fe	554.81	719.16	**636.99**
Mean	**522.13**	**648.24**	
	I	**Fe**	**I × Fe**
SE(d) ±	39.43	56.29	79.10
CD at 5 %	81.38	116.12	N.S.

Table.2 Effect of iron and *Rhizobium* on nitrogen uptake (mg pot^{-1}) in stover of chickpea

Treatment	Uninoc.	Inoc.	Mean
0 ppm Fe	134.98	158.88	**146.93**
2.5 ppm Fe	155.39	185.47	**170.43**
5.0 ppm Fe	172.14	212.36	**192.25**
7.5 ppm Fe	162.58	207.44	**185.01**
Mean	**156.27**	**191.04**	
	I	**Fe**	**I × Fe**
SE(d) ±	5.42	7.21	9.13
CD at 5 %	11.19	14.88	N.S.

Table.3 Effect of iron and *Rhizobium* on phosphorus uptake (mg pot^{-1}) in grain of chickpea

Treatment	Uninoc.	Inoc.	Mean
0 ppm Fe	75.80	105.92	**90.86**
2.5 ppm Fe	84.25	120.38	**102.32**
5.0 ppm Fe	89.76	133.03	**111.40**
7.5 ppm Fe	83.91	125.05	**104.48**
Mean	**83.43**	**121.10**	
	I	**Fe**	**I × Fe**
SE(d) ±	8.43	12.16	16.20
CD at 5 %	17.40	25.10	N.S.

Table.4 Effect of iron and *Rhizobium* on phosphorus uptake (mg pot^{-1}) in stover of chickpea

Treatment	Uninoc.	Inoc.	Mean
0 ppm Fe	49.79	57.23	**53.51**
2.5 ppm Fe	55.75	65.43	**60.59**
5.0 ppm Fe	60.92	74.03	**67.48**
7.5 ppm Fe	57.26	71.96	**64.61**
Mean	**55.93**	**67.16**	
	I	**Fe**	**I × Fe**
SE(d) ±	4.26	6.29	8.24
CD at 5 %	8.79	12.98	N.S.

Table.5 Effect of iron and *Rhizobium* on iron uptake (mg pot^{-1}) in grain of chickpea

Treatment	Uninoc.	Inoc.	Mean
0 ppm Fe	0.810	1.074	**0.942**
2.5 ppm Fe	1.053	1.446	**1.250**
5.0 ppm Fe	1.257	1.783	**1.520**
7.5 ppm Fe	1.211	1.769	**1.490**
Mean	**1.083**	**1.518**	
	I	**Fe**	**I × Fe**
SE(d) ±	0.0006	0.0009	0.0012
CD at 5 %	0.0012	0.0018	N.S.

Table.6 Effect of iron and *Rhizobium* on iron uptake (mg pot^{-1}) in stover of chickpea

Treatment	Uninoc.	Inoc.	Mean
0 ppm Fe	1.492	1.950	**1.721**
2.5 ppm Fe	1.964	2.601	**2.283**
5.0 ppm Fe	2.268	3.238	**2.753**
7.5 ppm Fe	2.173	3.205	**2.689**
Mean	**1.974**	**2.749**	
	I	**Fe**	**I × Fe**
SE(d) ±	0.0014	0.0020	0.0028
CD at 5 %	0.0029	0.0041	N.S.

On an average, the phosphorus uptake of 67.48 mg pot^{-1} recorded at 5.0 ppm Fe was computed 26.11 percent higher than the phosphorus uptake of 53.51 mg pot^{-1} recorded with 0 ppm Fe (control). It is also apparent from the data that *Rhizobium* treatment of seeds enhanced the accumulation of phosphorus in stover significantly in comparison to un-inoculation (Table 4). On an average, the phosphorus uptake of 67.16 mg pot^{-1} recorded with inoculation was found 20.08 percent higher than the phosphorus uptake of 55.93 mg pot^{-1} recorded with un-inoculation. The interaction of iron levels and *Rhizobium* inoculation did not have significant effect on phosphorus uptake in stover.

The iron application has the antagonistic effect on the availability of phosphorus in the soil. Yadav *et al*., (2002) observed depressing effect of iron on content and uptake of phosphorus on mungbean crop. These present findings are also supported by the results of Singh *et al*., (1993).

Iron uptake in grain and stover

The data on iron uptake in grain as influenced by iron levels and *Rhizobium* inoculation have been illustrated in table 5. However, interaction between the iron level and *Rhizobium* inoculation did not affect iron uptake in grain. Likewise, nitrogen and phosphorus uptake, iron uptake also increased with increase in iron level up to 5.0 ppm Fe and thereafter, decreased at 7.5 ppm Fe level. On an average, the iron uptake of 1.520 mg pot^{-1} recorded with 5.0 ppm Fe was computed 61.36 percent higher than the iron uptake of 0.942 mg pot^{-1} recorded with control (0 ppm Fe).

The *Rhizobium* inoculation had significant positive effect on iron uptake in grain in comparison to un-inoculation. On an average, the iron uptake of 1.518 mg pot^{-1} recorded with inoculation was found 40.17 percent higher than the iron uptake of 1.083 mg pot^{-1} obtained with un-inoculation, Kantar *et al*., (2003).

The relevant data on iron uptake in stover as influenced by application of graded doses of iron and *Rhizobium* treatment of seeds has been given in table 6. The interaction, I × Fe, had not significant effect on iron uptake in stover. It is quite obvious from the data that iron application showed significant positive effect on iron uptake in stover also. It increased up to 5.0 ppm Fe and thereafter, decreased at 7.5 ppm Fe level. On an average, the iron uptake of 2.753 mg pot^{-1} recorded at 5.0 ppm Fe was found 59.97 per cent higher than the iron uptake of 1.721 mg pot^{-1} recorded with no iron application (control). The *Rhizobium* treatment of seeds also exhibited significant positive effect on iron uptake in stover in comparison to un-inoculation (Table 6). On an average, the iron uptake of 2.749 mg pot^{-1} recorded with inoculation was computed 39.26 per cent higher than the iron uptake of 1.974 mg pot^{-1} recorded with un-inoculation. The treatment of seeds with *Rhizobium* culture had significant positive effect on content and uptake of nitrogen, phosphorus and iron in both grain and stover in comparison to un-inoculation. The *Rhizobium* inoculation of seeds resulted in higher nitrogen fixation and nitrogen has positive relationship with nitrogen, phosphorus and iron. Therefore, in the present study, the concentration of nitrogen, phosphorus and iron and their uptake increased significantly with *Rhizobium* inoculation in comparison to un-inoculation. These results are concordantly supported by the findings of Mahmud *et al.*, (1997) and Raghuwanshi *et al*., (2003).

From the results narrated above, it could be concluded that application of 5.0 ppm Fe and *Rhizobium* inoculation of seeds is increased the nutrient uptake in chickpea.

References

Chapman, H.D. and Pratt, F. 1961. Methods of analysis for soils, plant and water. University of California, U.S.A., 309.

Ghasemi-Fasaei, R., Ronaghi, A., Maftoun, M., Karimian, N.A. and Soltanpour, P.N. 2007. Iron-manganese interaction in chickpea as affected by foliar and soil application of iron in a calcareous soil. *Communications in Soil Sci. Plant Analysis*, 36(13/14): 1717-1725.

Horn, C.P., Dalal, R.C., Birch, C.J. and Doughton, J.A. 1996. Sowing time and tillage practice affect chickpea yield and nitrogen fixation. Nitrogen accumulation, nitrogen fixation and soil nitrogen balance. *Australian J. Experimental Agri.*, 36(6): 701-706.

India Stat. 2011 – 12.

Jackson, M.L. 1973. Soil chemical analysis. Prentice Hall of India (Pvt.) Ltd., New Delhi.

Kantar, F., Elkoca, E., Ogutcu, H. and Algur, O.F. 2003. Chickpea yields in relation to *Rhizobium* inoculation from wild chickpea at high altitudes. *J. Agronomy and Crop Sci.*, 189(5): 291-297.

Mahmud, M.S., Salaiman, A.R.M., Hoque, M.S. and Hashem, M.A. 1997. Influence of *Rhizobium* inoculants and nitrogen on nodulation, growth and nitrogen uptake of lentil. *Annals of Bangladesh Agri.*, 7(2): 139-143.

Mehrotra, S.C., Sharma, C.P. and Agarwala, S.C. 1990. Iron-phosphorus interaction in chickpea genotypes that differ in tolerance to iron-stress. *Proceedings of the International Congress of Plant Physiology*, 2: 1146-1150.

Raghuwanshi, K.S., Patil, J.D. and Sawant, D.M. 2003. Response of chickpea to *Rhizobium* strains under dryland conditions. *J. Maharashtra Agri. Univ.*, 28(2): 207-208.

Sattar, M.A., Quadar, M.A. and Danso, S.K.A. 1993. Nodulation nitrogen fixation and yield of chickpea as influenced by host cultivar and Brady*Rhizobium* strain differences. *Soil Biol. Biochem.*, 27(4/5): 725-727.

Shukla, V. and Shulka, I.C. 1994. Effect of Fe, Mo, Zn and P on symbiotic nitrogen fixation of chickpea. *Indian J. Agri. Chem.*, 32: 118-123.

Singh, V. Singh, R.P. and Khan, Nizamuddin. 1993. Effect of P and Fe application on the yield and nutrient contents in chickpea. *J. Indian Society of Soil Sci.*, 41(1): 186-187.

Yadav, P.S., Kameriya, P.R. and Rathore, S. 2002. Effect of P and Fe fertilization on yield, content and nutrient uptake in mungbean on loamy sand soil. *J. Indian Society of Soil Sci.*, 50(2): 225-226.

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