

Original Research Article

<https://doi.org/10.20546/ijcmas.2018.703.269>

Effect of Iron Fertilization on Nitrogen and Iron Content, Uptake and Quality Parameters of Groundnut (*Arachis hypogaea* L.)

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ABSTRACT

A field experiment was conducted to study the effect of iron fertilization on nitrogen and iron content, uptake and quality parameters of groundnut (*Arachis hypogaea* L.) during *khariif*, 2016 at instructional farm, SKRAU, Bikaner. The results revealed that application of FeSO₄ @ 25 kg ha⁻¹ as basal + foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS+ Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha⁻¹ significantly increased nitrogen and iron content, uptake and quality parameters of groundnut. Nitrogen and iron content and uptake and protein content in kernels also enhanced with application of FeSO₄ @ 25 kg ha⁻¹ as basal + Foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS+ Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha⁻¹. However, oil content was not influenced due to soil and foliar applied iron treatment alone or in combinations. Similarly, Application of FeSO₄ @ 25 kg ha⁻¹ as basal + foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha⁻¹ significantly increased nitrogen and iron content and uptake in kernel over control and at par with foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha⁻¹ as basal application treatment.

Keywords

Citric acid, FYM,
Groundnut, Iron

Article Info

Accepted:

20 February 2018

Available Online:

10 March 2018

Introduction

In the Indian oil seed scenario groundnut (*Arachis hypogaea* L.) is the largest component and occupies 40% of total oilseeds area, contributing 60 % of total production. It is world's largest source of edible oil and ranks 13th among the food crops and 4th most important oil seed crops of the world. Groundnut seed (kernel) contains 44–50 % oil, 26% protein and 10-20% carbohydrate. Groundnut seeds are good source of vitamin E, calcium, phosphorus, magnesium, zinc,

iron, riboflavin, thiamine and potassium. Oil extracted from the kernel is used for culinary purpose. The residual *i.e.* oil cake contains 7 to 8 % N, 1.5 % P₂O₅ and 1.2 % K₂O and can be used as manure. Among groundnut producing countries of the world, India stands first by occupying about 38% of total area.

Iron involved in the formation of chlorophyll even though it is not its constituent. Iron is a constituent of large number of metabolically active compounds like cytochromes (b, b₆, c₁ and a₃), heme and non-heme enzymes and

other functional metal proteins such as ferredoxin and haemoglobin. Thus, best known role of iron is its catalytic function in biological oxidation-reduction and other metabolic processes in plants like oxidative photophosphorylation during cell respiration. It is also known to be involved in carbohydrate metabolism. Yadav (2009) conducted an experiment at Bikaner and observed that increasing FeSO₄ level up to 50 kg ha⁻¹ increased nutrient Fe content and nutrient uptake (N, P,S and Fe) in kernels, haulm and shell and protein content in kernels of groundnut. Similarly, Meena *et al.*, (2013) showed that the nutrient concentration and their uptake in mungbean was higher due to application of FeSO₄ @ 25 kg ha⁻¹ in comparison to control in Bikaner (Rajasthan).

The pH has a significant influence on the solubility of iron, which is minimum in pH range - 7.4 to 8.5, main characteristic of calcareous soils (Loeppert and Hallmark, 1985). Calcareous soils may contain high levels of total Fe, but in unavailable form. Visible Fe deficiency or Fe chlorosis is common in many plant growths in calcareous soil. However, owing to the nature and causes of Fe chlorosis, leaf Fe concentrations is not necessarily related to degree of chlorosis. In chlorotic plants iron concentrations can be higher or lower than those in normal plants. Inorganic iron can maintain this level of soluble Fe only in soils with pH between 5.5 and 6.0.

Foliar sprays of Fe-compound are commonly used as a means of controlling lime induced chlorosis of field crops grown on calcareous soil. But spraying with iron salts alone has been usually found to be relatively less effective because of precipitation of iron from the spray solution and poor translocation of applied iron within the plant (Chen and Barak, 1982). However, poor seed yield of groundnut may result from insufficient iron (Fe) uptake

and poor biological nitrogen (N) fixation due to high bicarbonate and pH in soils in the IGP region of South Asia is lacking. In this backdrop, the objectives of present study were to determine the effect of iron fertilization on nitrogen and iron content, uptake and quality parameters of groundnut

Materials and Methods

Experimental site, soil and Climate characteristics

Field experiment was conducted to study the effect of iron fertilization on growth, yield and quality of groundnut (*Arachis hypogaea* L.) during *kharif*, 2016 at Instructional Farm, College of Agriculture, Swami Keshwanand Rajasthan Agricultural University, Bikaner (28.01°N latitude and 73.22°E longitude at an altitude of 234.70 meters above mean sea level).

The soil of the experimental field was loamy sand in texture, alkaline in reaction low in organic carbon low in available nitrogen, medium in available phosphorus and low in available potassium. The initial soil characteristics of the experimental field are presented in table 1.

Experimental site represented the arid climate average annual rainfall of about mm. More than 80 per cent of rainfall is received in *kharif* season (July-September) by the south west monsoon.

During growing season, the maximum temperature may go as high as 44.4°C while in the winters it may fall as low as 14.0°C and crop received 340 mm of rainfall in 21 rainy days in the growing season. Pan evaporation ranged from 5.7 to 15.7 mm per day during the crop growing period and average relative humidity during the experimental season fluctuated between 43.9 to 76.2% (Fig. 1).

Treatments and experimental design

Twelve iron fertilization treatments viz. control (water spray), FeSO₄ basal @ 25 kg ha⁻¹, foliar spray of citric acid @ 0.1% at 45 and 75 DAS, foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS, FeSO₄ basal (25 kg ha⁻¹) + 5 ton FYM ha⁻¹, FeSO₄ basal (25 kg ha⁻¹) + foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS, foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + citric acid @ 0.1% at 45 and 75 DAS, FeSO₄ basal @ 25 kg ha⁻¹ + citric acid @ 0.1% at 45 and 75 DAS + 5 ton FYM ha⁻¹, FeSO₄ basal @ 25 kg ha⁻¹ + foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + citric acid @ 0.1% at 45 and 75 DAS, foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + citric acid @ 0.1% at 45 and 75 DAS + 5 ton FYM ha⁻¹, FeSO₄ basal @ 25 kg ha⁻¹ + FeSO₄ @ 0.5% at 45 and 75 DAS + 5 ton FYM ha⁻¹, FeSO₄ basal @ 25 kg ha⁻¹ + foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + citric acid @ 0.1% at 45 and 75 DAS + 5 ton FYM ha⁻¹ were tried in randomized block design with three replications. Crop sown at a distance of 30 cm and 10 cm plant to plant distance within row and net plot size 2.4 m X 3.0 m.

Crop establishment and management

The seed of groundnut variety HNG-10 was sown using 100 kg seed ha⁻¹ at the depth of 5 cm on 21st June, 2016 manually in the furrow already opened by hand drawn seed drill. The seed was treated with Chloropyriphos @ 4 ml kg⁻¹ seed just before sowing to ensure protection from soil borne insects and termites.

Hand weeding was done manually 20 and 40 DAS with the help of hand hoe to keep the field weed free. Pre-sowing irrigation (*palewa*) of 60 mm was applied before field preparation to ensure uniform and adequate moisture at sowing time and later all irrigation applied on the base of crop requirement.

Treatment application and analysis

Iron as per treatment was applied through ferrous sulphate (FeSO₄.7H₂O) containing 19 per cent iron and 10.5 per cent sulphur. The weighed quantity of ferrous sulphate was broadcasted uniformly in earmarked plots and thoroughly mixed in soil before sowing. For foliar spray treatment stock solution of 0.5 per cent FeSO₄ and 0.1 per cent citric acid were prepared separately. FeSO₄ and citric acid was applied using 500 liters of water separately or together as per treatment at 45 and 75 DAS. Similarly, measured quantity of FeSO₄ along with or without Lime (as per treatment) were mixed in water using 500 liters' water per hectare and sprayed at 45 and 75 DAS. The calculated quantity of chemical fertilizers as per treatment was applied at the time of bed preparation in respective treatment. Urea and Di Ammonium phosphate (DAP) were used as source of nitrogen and phosphorus, respectively.

Seed samples meant for iron determination were first washed with distilled water followed by 0.1 N HCl and finally with glass distilled water. After drying in air and then in oven at 70^oC, these samples were finally grinded and digested in di-acid mixture (HNO₃:HClO₄, 3:1 ratio). Estimation of nitrogen was done by colorimetric method using spectrophotometer after development of colours with Nessler's reagent. Nitrogen was calculated and express as percentage. Iron in the acid extract was determined by atomic absorption spectrophotometer (Lindsay and Norwell, 1978) and expressed in ppm. A composite sample of 100 gram was drawn from the bulk of the dry pods of each net plot randomly and shelled. The ratio of kernel to pod weight was worked out and expressed in per cent. Oil content in kernel was determined by Soxhlet apparatus using petroleum ether (60-80^oC) as an extractant (A.O.A.C., 1960). Protein per cent in kernels was calculated by

multiplying nitrogen concentration percentage in kernel by the factor of 6.25 (A.O.A.C., 1960).

Results and Discussion

Effect of iron fertilization on nitrogen content and uptake in groundnut kernels

An iron fertilization management practices showed significant ($p=0.05$) effect on nitrogen content, uptake and protein content (Table 2). Nitrogen content (3.75%) in seed was recorded maximum under the treatment $FeSO_4 @ 25 \text{ kg ha}^{-1}$ as basal + Foliar spray of $FeSO_4 @ 0.5\%$ at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha^{-1} which was significantly higher over control but it was at par with the treatment of Foliar spray of $FeSO_4 @ 0.5\%$ at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha^{-1} . The increase in nitrogen content was to the tune of 2.87 and 3.75 per cent over control, respectively. Jharia (2002) reported that application of Fe up to 5 $kg ha^{-1}$ significantly increased the nutrient content N, P, and K content of seed.

Nitrogen uptake in seed was recorded maximum under the treatment $FeSO_4 @ 25 \text{ kg}$

ha^{-1} as basal + Foliar spray of $FeSO_4 @ 0.5\%$ at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha^{-1} followed by foliar spray of $FeSO_4 @ 0.5\%$ at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha^{-1} (T10) and significantly superior to control (Table 2).

Similarly, Meena *et al.*, (2013) showed that the nutrient concentration and their uptake in mungbean was higher due to application of $FeSO_4 @ 25 \text{ kg ha}^{-1}$ in comparison to control in Bikaner (Rajasthan). Rao *et al.*, (2002) found that application of FYM @ 10 tons ha^{-1} as organic manure increased uptake of N significantly over the control.

Effect of iron fertilization on protein content and oil yield

Protein content (23.42%) in kernel of groundnut were recorded maximum under $FeSO_4 @ 25 \text{ kg ha}^{-1}$ as basal + Foliar spray of $FeSO_4 @ 0.5\%$ at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha^{-1} followed by 23.38% under Foliar spray of $FeSO_4 @ 0.5\%$ at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha^{-1} and the minimum 17.92% in control (Table 2).

Table.1 Initial status (kharif, 2016) of soil properties at the experimental site

Soil properties	Value (0-15 cm.)	Soil properties	Value (0-15 cm.)
A. Mechanical Composition		C. Chemical properties	
Sand (%)	85.50	Organic carbon (%)	0.07
Silt (%)	7.55	Available N ($kg ha^{-1}$)	89.25
Clay (%)	6.95	Available P_2O_5 ($kg ha^{-1}$)	19.5
Texture	loamy Sand	Available K_2O ($kg ha^{-1}$)	190.35
B. Physical properties		Available S (ppm)	7.3
Bulk density ($Mg m^{-3}$)	1.63	Available Fe (ppm)	1.98
Particle density ($Mg m^{-3}$)	2.66	EC ($dS m^{-1}$) (1:2 soil water suspension at 25°C)	0.15
Porosity (%)	37.80	Soil pH (1:2 soil water suspension at 25°C)	8.38

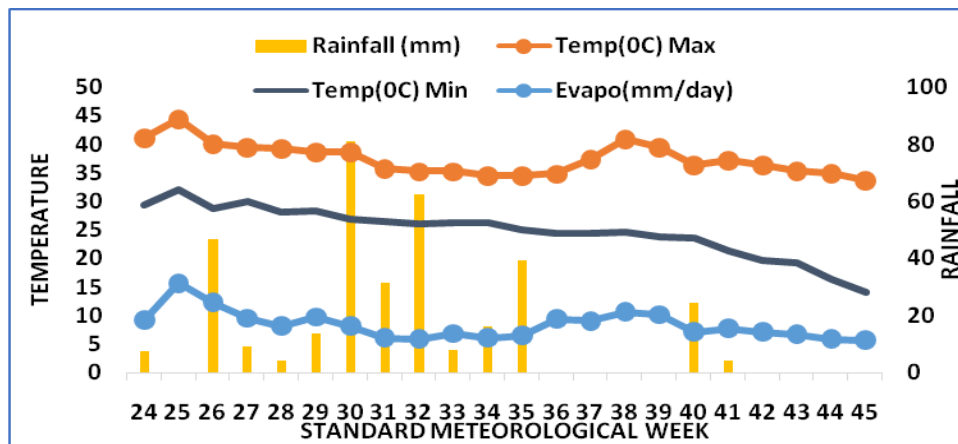
Table.2 Effect of iron fertilization on nitrogen content, uptake and Protein content in groundnut kernels

Treatments		Quality parameters			
		Nitrogen content (%)	Nitrogen uptake in kernels (kg ha ⁻¹)	Protein content in kernel (%)	Oil yield (kg ha ⁻¹)
T ₁	Control (water spray)	2.87	41.51	653	653
T ₂	FeSO ₄ basal @ 25 kg ha ⁻¹	2.94	48.92	760	760
T ₃	Foliar spray of Citric acid @ 0.1% at 45 and 75 DAS	2.91	42.39	664	664
T ₄	Foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS	3.03	51.68	789	789
T ₅	FeSO ₄ basal (25 kg ha ⁻¹) + 5 ton FYM ha ⁻¹	3.32	67.95	861	861
T ₆	FeSO ₄ basal @ 25 kg ha ⁻¹ + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS	3.25	56.90	813	813
T ₇	Foliar spray of FeSO ₄ @ 0.5% at 45 and 75 (DAS) + Citric acid @0.1% at 45 and 75 DAS	3.20	55.95	809	809
T ₈	FeSO ₄ basal @25 kg ha ⁻¹ + Citric acid @ 0.1% at 45 and 75 DAS + 5 ton FYM ha ⁻¹	3.72	68.14	864	864
T ₉	FeSO ₄ @ 25 kg ha ⁻¹ as basal + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS	3.59	64.30	826	826
T ₁₀	Foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha ⁻¹	3.74	73.19	927	927
T ₁₁	FeSO ₄ basal (25 kg ha ⁻¹) + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS+ 5 t FYM ha ⁻¹	3.71	68.84	872	872
T ₁₂	FeSO ₄ @ 25 kg ha ⁻¹ as basal + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS+ Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha ⁻¹	3.75	73.21	942	942
	SEm±	0.04	3.17	0.46	0.46
	CD (P=0.05)	0.14	9.30	1.37	1.37

Table.3 Effect of iron fertilization on Iron content and uptake in groundnut kernel

Treatment		Iron content in kernel (ppm)	Iron uptake (g ha ⁻¹) in kernel
T ₁	Control (water spray)	266.48	385.87
T ₂	FeSO ₄ basal @ 25 kg ha ⁻¹	292.70	491.84
T ₃	Foliar spray of Citric acid @ 0.1% at 45 and 75 DAS	266.58	392.68
T ₄	Foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS	304.36	519.13
T ₅	FeSO ₄ basal (25 kg ha ⁻¹) + 5 ton FYM ha ⁻¹	396.21	723.75
T ₆	FeSO ₄ basal @ 25 kg ha ⁻¹ + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS	389.22	679.50
T ₇	Foliar spray of FeSO ₄ @ 0.5% at 45 and 75 (DAS) + Citric acid @ 0.1% at 45 and 75 DAS	387.23	676.91
T ₈	FeSO ₄ basal @ 25 kg ha ⁻¹ + Citric acid @ 0.1% at 45 and 75 DAS + 5 ton FYM ha ⁻¹	396.22	725.25
T ₉	FeSO ₄ @ 25 kg ha ⁻¹ as basal + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS+ Citric acid @ 0.1% at 45 and 75 DAS	393.88	705.60
T ₁₀	Foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha ⁻¹	401.91	786.61
T ₁₁	FeSO ₄ basal (25 kg ha ⁻¹) + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS+ 5 t FYM ha ⁻¹	395.88	734.54
T ₁₂	FeSO ₄ @ 25 kg ha ⁻¹ as basal + foliar spray of FeSO ₄ @ 0.5% at 45 and 75 DAS+ Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha ⁻¹	404.50	789.86
SEm±		2.15	31.14
CD (P=0.05)		6.31	91.35

Fig.1 Mean weekly meteorological data recorded during crop growing season, 2016



An Iron fertilization had significant effect on oil yield and highest oil yield (942 Kg ha⁻¹) was recorded with FeSO₄ @ 25 kg ha⁻¹ as basal + Foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS +

5 t FYM ha⁻¹ followed by Foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha⁻¹ (T10) which gave oil yield of 927 kg ha⁻¹ (Table 2). Higher oil yield may be due to higher iron

availability in alkaline soils of Rajasthan, which ensured better biosynthesis of oil in groundnut. Yadav (2009) conducted an experiment at Bikaner and observed that increasing FeSO₄ level up to 50 kg ha⁻¹ increased protein content in kernels of groundnut.

Effect of iron fertilization on iron content and uptake

Significantly higher iron content (404.50 ppm) and uptake by kernel of groundnut recorded under the treatment FeSO₄ @ 25 kg ha⁻¹ as basal + Foliar spray of FeSO₄ @ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha⁻¹ followed by foliar spray of FeSO₄@ 0.5% at 45 and 75 DAS + Citric acid @ 0.1% at 45 and 75 DAS + 5 t FYM ha⁻¹ (T₁₀) which recorded 786.61 kg ha⁻¹ iron uptake by kernel (Table 3). Anita Mann *et al.*, (2015) conducted a field study to evaluate the effect of iron source through foliar as well as basal applications of iron increased active Fe content in groundnut.

Acknowledgements

We also acknowledge the financial support and facilities provided by college of agriculture Bikaner and S.K. Rajasthan Agricultural University, Bikaner (Rajasthan), India to carry out this research. Senior author is grateful to all those who contributed directly and indirectly during the course of his M.Sc research.

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How to cite this article:

Tanuja Poonia, S.R. Bhunia and Rakesh Choudhary. 2018. Effect of Iron Fertilization on Nitrogen and Iron Content, Uptake and Quality Parameters of Groundnut (*Arachis hypogaea* L.). *Int.J.Curr.Microbiol.App.Sci*. 7(03): 2297-2303. doi: <https://doi.org/10.20546/ijcmas.2018.703.269>