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Effect of Iron Fertilization on Growth, Yield and Economics of Groundnut (*Arachis hypogaea* L.)

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Abstract

A field experiment was conducted to study the effect of iron fertilization on growth, yield and quality of groundnut (*Arachis hypogaea* L.) during *kharif*, 2016 (June to September at instructional farm, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India. Twelve iron fertilization treatments *viz*. T_1: control (water spray); T_2: $FeSO_4$ basal @ 25 kg ha^{-1}; T_3: Foliar spray of citric acid @ 0.1% at 45 and 75 days after sowing (DAS); T_4: Foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS; T_5-T_2+5 ton FYM ha^{-1}; T_6- T_2+foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS; T_7: T_3+T_4; T_8: T_2+T_3+5 ton FYM ha^{-1}; T_9: T_2+T_3+T_4; T_{10}: T_3+T_4+5 ton FYM ha^{-1}; T_{11}: T_2+T_4+5 t FYM ha^{-1}; T_{12}: T_2+T_3+T_4+5 t FYM ha^{-1} were tried in randomized block design with three replications. Application of $FeSO_4$ @ 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} (T_{12}) found the best treatment combination with respect to pod yield, haulm yield and biological yield as compared to other treatment combinations. Treatment T_{12} improved the kernel yield by 37.2 and 18.2%, and straw (haulm) yield by 22.6 and 14.9% as compared to T_1 and T_2, respectively. Similarly, T_{12} recorded the ~49 and 20% higher net returns and ~20% higher B:C ratio as compared to T_1 and 17 and 2% as compared to T_2. The study showed that application of $FeSO_4$ both as basal and foliar spray along with citric acid and FYM application gives the best results in dry ecologies of western Rajasthan.

Keywords: Economics, dry mater accumulation, groundnut, iron sulphate, yields

1. 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. Groundnut seed contains about 50% oil, 25-30% protein, 20% carbohydrate and 5% fiber and ash which make groundnut a rich source of nutrition (Fageria et al., 1997). Groundnut seeds are good source of vitamin E, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium. Iron chlorosis in groundnut (appearance of papery whitish yellow bud leaves) is another problem of growing concern in many alkaline calcareous soils where bicarbonate ions hinder the uptake and translocation of Fe in the plant (Patel et al., 1993). Iron status in Bikaner soil is 2.5 to 4.5 ppm and 85% soil is iron deficient in the region. The beneficial effect of enriched organics (FYM and vermicompost) either Fe or Zn along with RDF on yield attributes character could be attributed to fact that enrichment techniques caused mobilization of the native nutrients to increase their availability to growing crops Rahevar et al. (2015). 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). Foliar sprays of Fe-compound is commonly used as a means of controlling lime induced chlorosis of field crops grown on calcareous soil (Kannan, 1984). However, Tiffin (1966) was of the opinion that acidification of spray solution or adding chelating compounds enhances absorption and translocation of applied iron within the plant besides checking its photochemical oxidation to ferric (Fe^{3+}) state. Foliar application of micronutrients in high pH saline soils is more beneficial in terms of growth and yield of the crop Zayed, *et al.* (2011). Foliar application of micronutrients is more beneficial as compared to soil application as the application rate of the nutrient is comparatively lesser, nutrient absorption is more moreover, when roots cannot provide necessary nutrients, foliar application is always a compatible alternative Hanwate et al. (2018). There is an increasing interest from producers about the potential benefits of foliar application of nutrients as a compliment of their fertilisation programs to maximise yields. Foliar fertilization with Fe fertilizers also has been used to correct Fe chlorosis in some crops where high pH or other environmental factors may reduce root uptake of soil-applied Fe. Application of iron chelates such as Fe-EDDHA were found highly effective in correcting Fe chlorosis in groundnut in alkali soils (Singh and Devi, 1992) while foliar application of Fe fertilizers correct Fe chlorosis in standing crop (Singh et al., 2003). 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 bicarbonates in the western part of Rajasthan. The information on application of Fe with other plant sources and their effects on yields are lacking in groundnut crop. With this backdrop, the present study was carried out with the hypothesis of whether combination of Fe application helps in improving yields (grain and straw; kernel, haulm) or not in groundnut.

2. Materials and Methods

2.1. 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 250 mm. More than 80% 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 day^{-1} during the crop growing period and average relative humidity during the experimental season fluctuated between 43.9 to 76.2% (Figure 1).

2.2. Treatments and experimental design

Twelve iron fertilization treatments viz. T_1: control (water spray), T_2: $FeSO_4$ basal @ 25 kgha^{-1} , T_3: Foliar spray of citric acid @ 0.1% at 45 and 75 DAS, T_4: Foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS, T_5: $FeSO_4$ basal (25 kg ha^{-1})+5 t FYM ha^{-1}, T_6: $FeSO_4$ basal (25 kg ha^{-1})+foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS, T_7: Foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS +citric acid @ 0.1% at 45 and 75 DAS, T_8: $FeSO_4$ basal @ 25 kg ha^{-1}+citric acid @ 0.1% at 45 and 75 DAS+5 t FYM ha^{-1}, T_9: $FeSO_4$ basal @ 25 kg ha^{-1}+foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS+citric acid @ 0.1% at 45 and 75 DAS, T_{10}: Foliar spray of $FeSO_4$ @ 0.5% at 45 and 75 DAS+citric acid @ 0.1% at 45 and 75 DAS+5 ton FYM ha^{-1}, T_{11}: $FeSO_4$ basal @ 25 kg ha^{-1} +$FeSO_4$ @ 0.5% at 45 and 75 DAS+5 ton FYM ha^{-1}, T_{12}: $FeSO_4$ basal @ 25 kg ha^{-1}+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} 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 the net plot size was 2.4×3.0 m^2.

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

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

2.3. 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. The 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. Well decomposed FYM was incorporated in soil as per treatments. Two spray of carbendazim @ 2.5 kg ha^{-1} were applied to control root rot. Prophylactic spray of Mencozeb

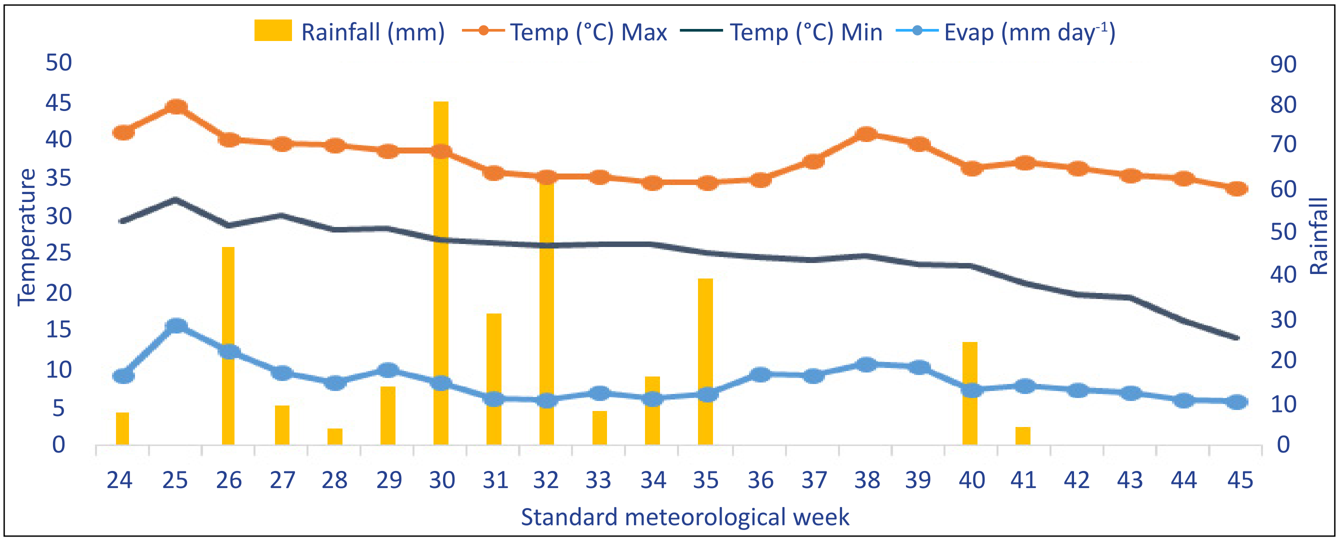

Figure 1: Mean weekly meteorological data recorded during crop growing *kharif* season, 2016

(Dithane M-45) 3 g l^{-1} was also done to control tikka disease. The crop was harvested manually by uprooting the whole plant when leaf veins started yellowing and about 80 per cent pods became fully mature.

2.4. *Plant sampling and analysis*

Plant stands were taken from three selected spot from sample row (1 m length) in each plot. Five plants were randomly selected for estimation of dry matter accumulation at 30, 60, 90 DAS and harvest. Chlorophyll content was measured using the method of Hiscox and Israelstem (1979). Accordingly, chlorophyll was extracted in DMSO and transmittance was recorded with spectro-photometer at 645 and 663 nm. Total chlorophyll content was worked out by adding chlorophyll "a" and chlorophyll "b".

The yields (pod and haulm) per plot was recorded by weighing the plants of each net plot area after complete drying and threshing and converted into kg ha^{-1}. After complete sun drying, harvested bundles of each net plot (2.4×3.0 m^2) were weighed for biological yield.

The economics of different treatments was worked out in terms of net returns and B:C ratio, based on prevailing market price for inputs and outputs. The cost of cultivation for each treatment was subtracted from the gross returns for calculating the net returns. Benefit: cost ratio was the ration of gross returns (ha^{-1}) to the total cost of cultivation (ha^{-1}). The data

were analysed with the help of analysis of variance (ANOVA) technique (Gomez and Gomez, 1984) for randomized block design and the treatment differences were compared at 5% level of significance.

3. Results and Discussion

An iron fertilization management practices showed significant (p=0.05) effect on growth & yield parameters and yield in groundnut crop study.

3.1. *Effect of iron fertilization on growth and yield parameters*

Iron fertilization had significant effect on growth parameters *viz*. dry matter accumulation and chlorophyll content. However, there was no significant variation in plant population recorded at harvest due to different iron fertilization (Table 2). Total dry matter production of groundnut increased with

Table 2: Effect of iron fertilization on plant stand (Lakh ha^{-1}), dry matter accumulation (DMA) and total chlorophyll content (mg g^{-1} fresh weight of leaves) in groundnut

Treatment	Plant stand	DMA			Chlorophyll content
	At harvest	60 DAS	90 DAS	At maturity	At 90 DAS
T_1	2.62	15.51	21.40	30.08	1.94
T_2	2.65	17.86	23.73	32.60	2.10
T_3	2.63	15.62	21.60	30.30	1.95
T_4	2.67	17.73	23.69	31.80	2.51
T_5	2.74	19.16	26.56	35.40	3.37
T_6	2.70	18.56	25.61	34.84	2.40
T_7	2.69	18.35	24.86	34.10	2.24
T_8	2.75	19.19	26.60	36.50	3.38
T_9	2.73	19.17	26.57	35.41	3.01
T_{10}	2.76	19.89	27.26	37.40	3.39
T_{11}	2.74	19.23	26.73	36.09	3.37
T_{12}	2.78	20.60	27.86	37.74	3.41
SEm±	0.136	1.01	1.20	1.63	0.19
CD (p=0.05)	NS	2.97	3.52	4.78	0.57

Where, $FeSO_4$: Iron Sulphate; DAS: days after sowing; FYM: farm yard manure the advancement in growth both at 90 DAS and harvest. Highest dry matter accumulation per plant was recorded in $FeSO_4$ @ 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} (T_{12}) 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} (T_{10}) treatment as compared to other treatments. Highest chlorophyll content (3.41 mg g^{-1} fresh weight of leaves) in leave was recorded under $FeSO_4$ @ 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} and both the treatments were significantly superior 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} (T_{10}) to soil application of $FeSO_4$ or foliar spray of $FeSO_4$ or citric acid. Chlorophyll was increased the activities of catalase, guaiacol peroxidase, synthesis of chlorophyll and active iron content of green leaves over lower doses of Fe and control treatment. Patel et al. (1993) reported that foliar application of 1.0% $FeSO_4$+0.1% citric acid and 2.0% ferric citrate at 37 DAS on groundnut crop significantly increased chlorophyll content of leaves by 415.78 and 494.73% over control (0.19 mg g^{-1}), respectively. Similar results have also been reported Singh et al. (1998) and Meena et al. (2013) in mungbean. The increase in no. of pods $plant^{-1}$, no. of kernels pod^{-1}, pod and stover yield may be attributed to the fact that favorable nutritional environment in rhizosphere and absorption of iron by plant leaves led to increased photosynthesis efficiency and production of assimilates. The higher translocation of photosynthates in reproductive structures resulted in increased yield attributes which led to the increased pod and stover yield of groundnut. The results of present investigation are in conformity with those of Umamaheswari and Singh (2002).

Number of pod $plant^{-1}$ at maturity was significantly higher under with $FeSO_4$ @ 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} compared to other treatments (Table 3). This treatment recorded 31% higher number of pod $plant^{-1}$ compared with control. However, this treatment gave at par pod per plant 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} (30.67%). These finding similar with Panwar and Singh (2003) also found that application of 5 t FYM ha^{-1} along with bio-fertilizers significantly increased number of pod $plant^{-1}$ of groundnut. The highest number of kernels pod^{-1} (1.98) was recorded with $FeSO_4$ @ 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} and 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} (1.97) superior to the treatments.

Table 3: Effect of iron fertilization on yield attributes and yields

Treatment	Pods $plant^{-1}$	Kernels pod^{-1}	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Biological yield (kg ha^{-1})
T_1	27.33	1.79	2083	1448	5084	7167
T_2	28.33	1.83	2416	1680	5427	7843
T_3	28.00	1.81	2120	1473	5127	7246
T_4	28.67	1.86	2453	1705	5450	7903
T_5	29.33	1.93	2598	1827	5922	8520
T_6	29.33	1.91	2480	1747	5463	7943
T_7	29.00	1.89	2483	1789	5412	7895
T_8	30.33	1.96	2599	1830	5923	8521
T_9	29.67	1.92	2542	1848	5566	8108
T_{10}	30.67	1.97	2777	1936	5977	8754
T_{11}	30.00	1.94	2667	1856	5837	8504
T_{12}	31.00	1.98	2780	1986	6233	9013
SEm±	0.73	0.09	97	79	162	204
CD (p=0.05)	2.14	NS	286	233	477	598

The highest pods $plant^{-1}$ due to the foliar application could be attributed to iron's significant effect on reproductive organs, such as stamens and pollens, Seifi-Nadergholi (2011). The increase in the number of soybean pods confirmed the translocation of photosynthates to the productive sink. Application of Fe increases the number of pods per plant in mothbean Sachendra et al. (2006).Chelation of soil applied iron by organic acids released by decomposing of applied FYM as well as foliar application of iron whose availability is not affected by soil pH work in tandem and ensured higher yield attributes of groundnut (Yadav, 2009). Rapid availability of iron to plants due to foliar application of chelated Fe and soil applied $FeSO_4$. Moreover, application of FYM also might have resulted increased concentration of plant available iron and formation of metalo-organic complexes of higher extractability which in turn might have resulted in continuous supply of iron. The enhanced availability of iron could have increased chlorophyll content and accumulation more carbohydrates which is associated with increase in flowering and pod development ultimately increased grain yield of soybean. While, Foliar application of iron might have resulted in direct absorption of the foliage sprayed with Fe solution. The results conform to that of Sale et al. (2017) who observed increased soybean yields due to foliar nutrition of Fe and Zn. Similarly, Moosavi and Ronaghi (2011) also reported a substantial increase in soybean yield in response to foliar and soil iron nutrition.

3.2. *Effect of iron fertilization on yield*

The pod and karnel yield of groundnut were significantly influenced by soil, foliar or both application of $FeSO_4$ (Table 3). The maximum pod yield (2780 kg ha^{-1}) was recorded with $FeSO_4$ @ 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} treatment, but 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} (Table 4). Foliar sprays treatments viz. 0.5% $FeSO_4$, 0.1% citric acid alone or in combination at 45 and 75 DAS significantly improved pod yield in comparison to control treatment (2083 kg ha^{-1}). Karnel yield was higher 37.15% over control treatment. Zalate and Padmani (2009) found that application of FYM @ 6.0 t ha^{-1}+*Rhizobium*+PSM significantly increased the pod weight $plant^{-1}$ and number of mature pods $plant^{-1}$ of groundnut as compared to control. Application of poultry manure 3 t+½ RDF and Fe levels upto 10 kg ha^{-1} significantly increased the dry matter accumulation, branches $plant^{-1}$, dry weight of nodules, leaf area index, no. of pods $plant^{-1}$, no. of kernels pod^{-1}, pod yield and stover yield of groundnut (Chaudhri et al., 2017).

Table 4: Effect of iron fertilization on economics of groundnut

Treat-ment	Total cost (₹)	Gross return (₹)	Net return (₹)	B:C ratio
T_1	50466	108117	57651	2.14
T_2	51466	125015	73549	2.43
T_3	50922	110765	59843	2.17
T_4	50706	126734	76028	2.50
T_5	57066	134676	77610	2.36
T_6	51706	127974	76268	2.47
T_7	51162	127956	76794	2.50
T_8	57522	134708	77186	2.35
T_9	52162	131103	78941	2.51
T_{10}	56662	142882	86220	2.52
T_{11}	57306	137512	80206	2.40
T_{12}	57762	143813	86051	2.48
SEm±			4504	0.08
CD (*p*=0.05)			13212	0.23

Haulm and biological yield of groundnut recorded significantly highest under $FeSO_4$ @ 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} and closely 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} (Table 3). Application of FYM @ 5 t ha^{-1} with 5 kg Fe ha^{-1}+4 kg Zn ha^{-1} considerably increased yield, yield attributes and quality parameters of groundnut under North Gujarat Agro-climatic condition (Rahevar et al., 2015). The increase in pod and haulm yield with soil and foliar application of zinc and iron alone or in combination along with RDF might be due to continuous release of nitrogen, phosphorus, potassium, sulphur, iron and zinc throughout the crop growth and higher content and uptake of these nutrients by the crop lead to significant increase in growth viz., plant height, number of branches, dry matter and number of peg $plant^{-1}$ and yield attributes viz., number of pods $plant^{-1}$, pod weight, test weight and shelling % showed significantly positive correlation with pod and haulm yield of groundnut and also beneficial as well as favourable effect of zinc and iron when applied in combination soil and foliar increased the yield of crops. This was in agreement with Singh and Chaudhari (1997) in groundnut, Sonawane et al. (2010), Pareek and Poonia (2011) and Der et al. (2015) in groundnut.

3.3. *Effect of iron fertilization on economics*

Highest net returns and benefit cost ratio were recorded under 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 $FeSO_4$ @ 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} 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} (Table 4) favorable effect of iron fertilization on crop growth and yield attributes increased seed and haulm yield with concomitant increased in net returns. Similar results have been also reported by Kumawat et al. (2006) in mungbean. Lourduraj et al. (1998), Chandrasekaran et al. (2008), Guru Prasad et al. (2009) and Der et al. (2015), reported that maximum net returns (9785 ₹ ha^{-1}) in rainfed groundnut were realized with the application of 10:10:45: kg NPK ha^{-1} (RDF). However, it was at par with FYM @ 2.5 t ha^{-1}+75% RDF.

4. Conclusion

Basal application of Iron sulphate in combination with foliar spray and integration with other sources like citric acid and FYM results in higher crop growth and yields. The application of $FeSO_4$ @ 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} 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} gave maximum yield and net returns of groundnut.

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