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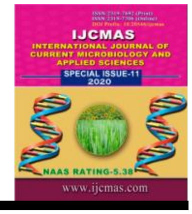

Original Research Article

Effect of Iron on Growth, Yield and Yield Attributing Parameters of Groundnut (*Arachis hypogaea* L.) under Hyper Arid Partially Irrigated Zone of Rajasthan

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ABSTRACT

Oilseeds crops have major role in Indian economy next to cereals. Among the oilseed crops, groundnut is an important edible oilseed crop of India. It is a major oil seed crop which ranks 12th position among the oil crops of the world. The district productivity is higher than the state average productivity. But the potential yield of groundnut varieties recorded on the research station was ranges between 2800 to 3500 Kg ha^{-1}. This means that the groundnut crop has still potentiality to increase the productivity. One of the major constraints for low yield of groundnut relates to deficiency of micronutrients. The Krishi Vigyan Kendra (KVK)-Bikaner-II has conducted a on farm trail on Effect of iron on growth, yield and yield attributing parameters of Groundnut (*Arachis hypogaea* L.) under Hyper Arid Partially Irrigated Zone of Rajasthan" to maximize the yield of groundnut. Groundnut yield and yield components viz. pods/plant, kernel/pod and yield/ha was influenced significantly by iron application. Data revels that average maximum number of pods/plant (45.0), no of kernel/pod (1.96) and yield (27.13 q/ha)was recorded with two foliar application of ferrous sulphate @0.5% + 0.1% citric acid at 45 and 60days after sowing along with recommended dose of fertilizers. The application of iron gave average yield enhancement to the tune of 18.73 %, over farmers practice. The average highest gross return (119642 Rs./ha), net return (88569 Rs./ha) and B:C ratio (3.83) was also observed in treatment $T_{2.}$

Keywords

Groundnut, Micronutrients (iron), Pod yield, Yield and Economics

Introduction

Oilseeds crops have major role in Indian economy next to cereals. Among the oilseed crops, groundnut is an important edible oilseed crop of India. Groundnut (*Arachis hypogaea* L.) is a crop of global importance. It is classified as both a grain legume and an oilseed crop, because of its high oil content. It 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). It is a major oil seed crop which ranks 12th position among the oil crops of the world. It is cultivated by millions of small farmers throughout the world, because of its economic and nutritional value. Groundnut seed can be consumed raw, boiled or roasted or crushed for edible oil. Its haulms are used as animal feed and shells that constitute about 25% of the total pod mass are used as fuel, filler in the feed and fertilizer industries and in manufacture of particle boards etc. The cake obtained after extraction of oil is used in animal feed industry and in making enriched, easily digestible food for children and aged persons. Groundnut oil is an excellent cooking medium because of its high smoking point. It can widely be used in food processing industries because of high proportion of unsaturated fatty acids (Singh and Diwakar, 1993). Groundnut is also used to make peanut butter, confectioneries and baked products. Seeds contain many health enhancing nutrients, minerals, antioxidants and vitamins, besides mono-unsaturated fatty acids. Oilseeds occupy a pride place in the Indian economy and groundnut is a kingpin among oilseeds grown in India. More than 80 per cent of groundnut production in the country is used for extraction of oil and about two per cent is exported for confectionary purposes. Commercially, groundnut is the world's fourth most important source of edible oil and third most important source of vegetable protein.

The major producers of groundnut in the world are China, India, Indonesia and the USA which together account for two-thirds of the world output. Groundnut occupies second position with regard to both area and production among the oil seed crop in India. In India, tt accounts about 4.81 m ha. and production (6.69 mt) with the productivity of 1393 kg/ha (Anonymous, 2019). In Rajasthan, groundnut is cultivated mainly in north-western region covering the districts of Bikaner, Jaipur, Jodhpur, Nagaur and Sikar. The area, production and productivity of groundnut in Rajasthan state is 670000 ha, 1.38 million tonnes and 2053Kg/ha, respectively(Anonymous. 2019). Groundnut is most favorable oilseed crop in Bikaner district. The area under groundnut cultivation in this district is 220552 ha with the average productivity of 2321 Kg/haduring 2017-18 (Anonymous, 2019).

The district productivity is higher than the state average productivity, But the potential yield of groundnut varieties recorded on the research station was ranges between 2800 to 3500 Kg ha^{-1}. This means that the groundnut crop has still potentiality to increase the productivity. The area under groundnut is increasing year by year. Several reasons are attributed for low yield levels *viz,* lack of improved high yielding cultivars, cultivation under shallow soils of low fertility, uneven rainfall distribution, continuous cropping without rotation of crop, low plant population, incidence of foliar diseases and lack of application of micronutrients. It is unpredictable, heavy feeder legume and is cultivated worldwide on almost all types of soil. In spite of recommended application of fertilizer (NPK – nitrogen, phosphorus, potassium) the yield does not reach the potential level. One of the major constraints for low yield of groundnut relates to deficiency of micronutrients. Intensification of agriculture, usage of straight fertilizers, rising crop requirements due to increasing productivity levels have heightened the micronutrients demand in soil fertility management and are increasingly becoming major constraints to achieve agricultural production. The incessant efforts for enhancing food grain production from shrinking land resources will further magnify the depletion of limited micronutrient reserves and would cause the deficiency of other micronutrients besides accentuating the existing ones. Though micronutrients were required in small amounts but play a key role in biochemical activities in plant. Iron is 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 ferrodoxin 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. It is related to vitamins, biological N-fixation and Cu, Zn, Mn, and Mg metabolism. It is widely agreed that iron is directly involved in protein synthesis. Plants under iron stress show considerable accumulation of nitrates, amino acids and amides and are low in protein content. Therefore, in the recent years micronutrients are considered important constraints in optimizing production of crops. Iron status in Bikaner soil is 2.5 to 4.5 ppm and 85% soil is iron deficient in the region. The optimization of mineral nutrition is the key to optimize the production of groundnut as it has very high nutrient requirement. Whereas, some of the recently released high yielding groundnut varieties remove even more macro and micronutrients from the soil.

On the contrary, groundnut growing farmers in most parts of the semi-arid region use very less micronutrient fertilizers and sometimes only one or two nutrients resulting in severe mineral nutrient deficiencies including micronutrients. 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). In Bikaner district, groundnut crop show yellowing of leaves which adversely affects the growth and yield attributing parameters due to deficiency of iron. Hence, a On Farm Trail on “Effect of iron on growth, yield and yield attributing parameters of Groundnut (*Arachis hypogaea* L.) under Hyper Arid Partially Irrigated Zone of Rajasthan” was carried out to maximize the yield of groundnut. The study was conducted in two blocks (Lunkaransar and Chhatargarh) of Bikaner district in Rajasthan.

Materials and Methods

The present study was carried out in 10 farmer’s field during three consecutive *Kharif* seasons of 2018,2019 and 2020 to evaluate the effect of foliar application of iron on growth, yield and yield attributing parameters of Groundnut. The area under each trial was 0.4 ha area and adjacent 0.4 ha was considered as control for comparison (farmer’s practice). The soil of the experimental field was neutral in pH (7.98), neutral in E.C. (0.38 dsm^{-1}), low in organic carbon (0.25%), low in N (163 kg/ha),P_2O_5 (20 kg/ha) and high in K_2O (275 kg/ha), sufficient in available sulphur (13.32 ppm) (Table 1). Whereas, availability of micronutrients Fe (2.80ppm) and Zn (0.16 ppm) were insufficient than their critical limits. For raising of a crop, recommended package of practices were followed. Before fertilizer application, random soil samples were taken from the farmers field and were analyzed for pH, EC, Soil texture, bulk density, Organic Carbon, Available N, Available P_2O_5, Available K_2O, Sulphar, Iron and Zinc. The climate of the area is typically semi-arid. Rainfall and temperatures are the two main elements of the climate.

The rainfall is seasonal and not properly distributed and it varies between 100 to 350 mm annually which is mostly received during the months of July to September. In summer maximum temperature ranges between 35^0C to 50^0C and in winter the minimum temperature varies from 8^0C to 12^0C.The treatments included: T_1: Farmers' Practice (No application of iron) and T_2: Two foliar application of ferrous sulphate @0.5% + 0.1% citric acid at 45 and 60days after sowing was given along with Recommended dose of fertilizers.

The observations were recorded on no. of pods per plant, no of kernel per pods, yield (q/ha) and economics of crop production. Based on the net plot yield, yield per hectare was calculated and expressed in quintal (q) per hectare. The yield data were collected from both the demonstration and farmers practice by random crop cutting method and analyzed by using simple statistical tools.

Results and Discussion

Effect of iron on yield and yield attributes

Groundnut yield and yield components viz. pods/plant, kernel/pod and yield/ha was influenced significantly by iron application (Table 2). Data revels that average maximum number of pods/plant (45.0), no of kernel/pod (1.96) and yield (27.13 q/ha) was recorded with two foliar application of ferrous sulphate @0.5% + 0.1% citric acid at 45 and 60days after sowing along with recommended dose of fertilizers, whereas, average minimum number of pods/plant (37.66), no of kernel/pod (1.53) and yield (22.86 q/ha) was recorded in farmers practices (Fig. 1).

Increase in number of pods/plant and kernel/pod of groundnut may be attributed to Fe which is known to enhance the nitrogen's activity resulting in the better nodule and peg formation thereby boosting the production of number of pods/plant which ultimately affects the yield in groundnut (Ali AG & Seyyed ANN (2010). Iron is directly or indirectly involved in the production of chlorophyll and deficiency of iron irreversibly damages chlorophyll synthesis (Jacobson and Oertli, 1956). In groundnut foliar application of iron, whose availability is not affected by soil pH work in tandem and ensured higher yield attributes of groundnut (Yadav and Meena, 2009).

Prasad *et al.,* (2000) also recorded significantly increased pod yield and halum yield by 27 and 8 per cent over control, due to foliar application of 0.5 per cent $FeSO_4.7H_2O$ at 40, 60 and 90 DAS in groundnut.

The possible cause for such positive role is enhance in the activity of bio-substances or activity of photosynthetic system (Quary *et al.,* 2006) or might be due to the active role of these trace-elements in metabolic processes of plants and photosynthesis and thus, reflected to increase the yield attributes and yield of groundnut.

Poonia (2018) also reported that application of FeSO4 @ 25 kg/haas 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 significantly increased pod yield, halum yield, biological yield, pod/plant, shalling percentage and seed index of groundnut.

The present results are in agreement with those of Bhardawaj (2003), Salih(2013), Alireza *et al.,* (2015) and Mekkdad (2017). The application of iron gave average yield enhancement to the tune of 18.73 %, over farmers practice (no use of iron).

Economic analysis

The inputs and outputs prices of commodities prevailed during all the year of demonstrations were taken for calculating cost of cultivation, net returns and benefit cost ratio (Fig. 2 and Table 3).

Table.1 Physico-chemical characteristics of the demonstration field (0-30 cm)

Soil parameters	Lunkaransar	Chattargarh	Average
pH	8.02	7.95	7.99
EC (*dS m*$^{-1}$)	0.45	0.31	0.38
Organic carbon (%)	0.23	0.28	0.26
Bulk density (Mg m^{-3})	1.55	1.45	1.50
Available N (kg ha^{-1})	166	160	163.00
Available P_2O_5 (kg ha^{-1})	18	22	20.00
Available K_2O (kg ha^{-1})	280	270	275.00
Available S (mg kg^{-1})	13.44	13.20	13.32
DTPA extractable Zn (mg kg^{-1})	0.17	0.16	0.17
DTPA extractable Fe (mg kg^{-1})	2.70	2.93	2.82
Soil texture	Sandy loam	Sandy loam	Sandy loam

Table.2 Effect of iron management on yield of groundnut

Year	(T_1)			(T_2)			**% Increase in yield over farmer's practice**
	No. of pods per plant	**kernal per pods**	**Yield (q/ha)**	**No. of pods per plant**	**kernal per pods**	**Yield (q/ha)**	
2018	35	1.5	21.3	42	1.9	25.8	21.12
2019	40	1.6	23.8	48	2.0	28.2	18.48
2020	38	1.5	23.5	45	2.0	27.4	16.59
Average	37.66	1.53	22.86	45	1.96	27.13	18.73

Table.3 Effect of iron management on Economics of groundnut

Year	(T_1)				(T_2)			
	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio	Cost of cultivation (Rs./ha)	Gross return (Rs./ha)	Net return (Rs./ha)	B:C ratio
2018	28500	80940	52440	2.84	29920	98040	68120	3.27
2019	29430	107100	77670	3.63	30500	126900	96400	4.16
2020	31500	114915	83415	3.64	32800	133986	101186	4.08
Average	29810	100985	71175	3.37	31073	119642	88569	3.83

Fig.1

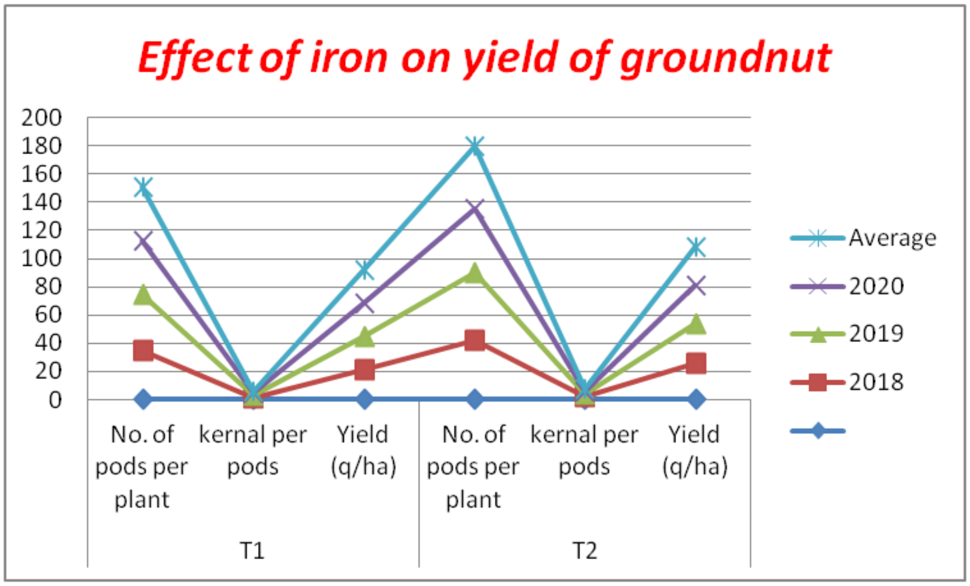
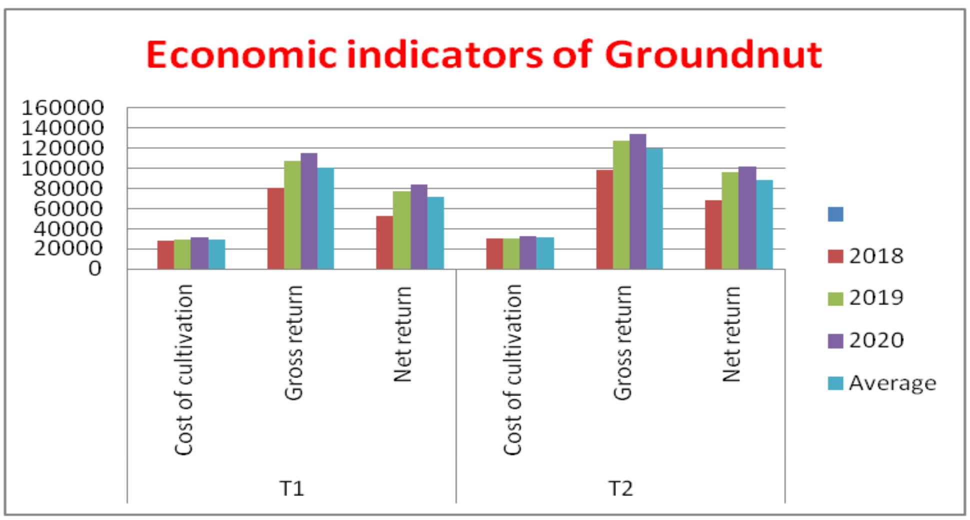


Fig.2



The results revealed (Table 3) that average highest gross return (119642 Rs./ha), net return (88569 Rs./ha) and B:C ratio (3.83) was observed in T_2 where two foliar application of ferrous sulphate @0.5% + 0.1% citric acid at 45 and 60days after sowing along with recommended dose of fertilizers was applied while lowest gross return (100985 Rs./ha), net return (7175 Rs./ha)and B:C ratio (3.37) was observed in farmer practices. Favorable effect of iron application on crop growth and yield attributes influenced seed and haulm yield with concomitant increased in B:C ratio.

The foliar application of ferrous sulphate in addition to recommended doses of NPK can be effective practice to deal with low productivity of the crop due to iron deficiency. Farmers of different villages showed positive response for the planning and execution of this technology however more awareness about judicious use of fertilizers is needed which can be done by proper soil testing and right interpretation of results. It was noticed that potential yield of crop can be achieved by giving scientific knowledge to the farmers, providing the good quality need based inputs and proper application of these inputs. However horizontal spread of recommended and improved technologies may be achieved by the successful implementation of results of on farm trials (OFT) and various extensions activities like training programmes, Kisangosthi, field day, farm school, exposure visit to universities/institutes etc.

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