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Effect of Chelated Zinc and Iron on the Growth and Yield of Summer Groundnut (*Arachis hypogaea* L.)

Sandeep S. Hadole*, Kritika Soni, P. A. Sarap, M. D. Sarode, Y. A. Reddy and S. D. Nandurkar

Department of Soil Science, Dr. Panjabrao Krishi Vidyapeeth, Akola- 444104, Maharashtra, India

**Corresponding author*

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A B S T R A C T

The field experiment entitled, Effect of Chelated zinc and iron on the growth and yield of Summer Groundnut (*Arachis hypogaea* L.) was undertaken during the summer 2022-23 at Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in Factorial Randomized Block Design (FRBD) with two factors (Soil application and Foliar spray of chelated micronutrients (ZnEDTA and FeEDDHA) replicated three times. The results of the present investigation revealed that the incorporation of chelated zinc and iron fertilizers significantly influenced the plant yield. The highest yield (Pod and Haulm) of summer groundnut was significantly with Soil application of chelated zinc and iron S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) along with foliar spray of chelated zinc and iron F_3 (Zn EDTA @ 0.5 % + FE EDDHA@ 1.0%at 35 and 65 DAS).

Introduction

Groundnut (*Arachis hypogaea* L.) is the world's fourth most important source of vegetable protein. Recent botanical survey has indicated that Brazil in South America is the most likely center of origin of this plant. It is also known as peanut, earthnut, monkeynut, manillanut, pinda, goober and kingpin of oilseeds, unpredictable legume and energy capsule. World production of groundnut reached a record of 21 million tonnes. The most important groundnut producing countries in world are India, China, USA, West Africa, Sudan and Nigeria etc. Micronutrient deficiencies are major constraints in crop production in present day agricultural programs. Micronutrient fertilizers are gaining importance day by day and would play a major role in bringing stability and sustainability in the production of food grains, pulses and oilseeds in the coming decade. Iron and zinc deficiency is a widespread agricultural problem in many crops, especially in groundnut in calcareous and alkaline soils. The Fe and Zn deficiency in groundnut first appears as chlorosis of young rapidly expanding leaves which is characterized by intervenial chlorosis and later severe deficiency. The yield loss

due to iron chlorosis was reported to be 16-40%.The plant availability of certain micronutrient fertilizers reduces by the transformation of the added micronutrients in to forms that plants are unable to absorb.

For Example, if the inorganic iron salt ($FeSO_4$) is supplied to some soils much of the iron is transformed into forms that are not readily assimilated. This problem can be overcome by chelates. Achelate is defined as a kind of organic molecule that is held so tightly that it cannot be stolen by contact with other substances. This makes them useful in agriculture. FeEDDHA and Zn EDTA are found to be highly effective in correcting chlorosis in alkali soils. Keeping all the above facts in view, the present investigation was undertaken with the objectives to study the "Effect of Chelated zinc and iron on the growth and yield of Summer Groundnut (*Arachis hypogaea* L.)"

Materials and Methods

The experiment entitled Effect of Chelated zinc and iron on the growth and yield of Summer Groundnut was carried out during the summer 2022-23 at Oilseed Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The site is situated in the sub-tropical region at $22^0$42' North latitude and $77^0$02' East longitude and at an altitude of 307.42 m above mean sea level. The experiment was laid out Factorial Randomized Block Design (FRBD) with two factors soil application and foliar spray. Factor A: Soil application having four levels S_0 -Control (RDF), S_1-Control (RDF) + Zn EDTA @ 1.5 kg ha^{-1}, S_2-Control (RDF) + Fe EDDHA @ 1.5 kg $ha^{-1}$and S_3- Control (RDF) + Zn EDTA @ 1.5 kg ha^{-1}+ Fe EDDHA @ 1.5 kg ha^{-1} and Factor B: Foliar spray having four levels F_0- water spray, F_1-@ 0.5 % Zn EDTA (35 & 65 DAS), F_2- @ 1.0 % Fe EDDHA (35 & 65 DAS) and F_3- @ 0.5 % Zn EDTA (35 & 65 DAS) + @ 1.0 % Fe EDDHA (35 & 65 DAS). The Recommended dose of NPK used were 20:50:30 kg ha^{-1} and the source of major nutrients are urea, single super phosphate and muriate of potash. The experimental data were recorded and analyzed statistically using Gomez and Gomez (1983).

Results and Discussion

Plant height

The data regarding height of plant as influenced by soil and foliar spray of chelated zinc and iron was recorded at 30, 60, 90 and at harvest days after sowing (DAS) and presented in Table 1.

Effect of Soil application

The effect of soil application of chelated zinc and iron on the height of the plant were found statistically non-significant. The maximum height was recorded in S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) (25.78 cm) which was at par with S_1 (100% RDF + ZnEDTA @ 1.5 kg ha^{-1}) (24.18 cm). The minimum height was recorded in S_0 (100% RDF) (22.93 cm) respectively. A similar result was in close agreement with the finding were reported by Der *et al.,* (2015) and Sudhagar *et al.,* (2019) who stated the increased in height of the plant due to application of Zn and Fe because of the increase in protein synthesis and cell growth.

Effect of foliar spray

The effect of foliar spray of chelated zinc and iron on the height of the plant were found statistically non-significant. The maximum height was recorded in F_3 (Zn EDTA @ 0.5 % + FeEDDHA @ 1.0% at 35 and 65 DAS) (25.32 cm) which was at par with F_1 (ZnEDTA @ 0.5% at 35 and 65 DAS) (23.48 cm). The minimum height was recorded in F_0 (Foliar spray of water) (21.91 cm) respectively. A similar result was in close agreement with the finding were reported by El-Haggan (2014); Der *et al.,* (2015) and Sudhagar *et al.,* (2019) stated the increase in height of the plant due to application of Fe and Zn because of the increase in protein synthesis and cell growth.

Effect of interaction

The interaction effect of soil and foliar spray of

chelated zinc and iron on the height of summer groundnut was statistically non-significant.

Number of nodules

The data regarding the no. of root nodules (30, 60, 90 and at harvest) DAS, as influenced by soil and foliar spray of chelated iron and zinc was presented in Table 2.

Effect of Soil application

The effect of soil application of chelated zinc and iron on number of root nodules at (30, 60, 90 and at harvest) was found to be statistically significant for 30 DAS and at harvest.

The maximum average number of root nodules for 30 DAS and at harvest was recorded in S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) (16.5, 21.58 $plant^{-1}$) respectively which was at par with S_2 (100% RDF + FeEDDHA @ 1.5 kg ha^{-1}) (15, 19.33 $plant^{-1}$) respectively. The minimum number of root nodules recorded in S_0 (100% RDF) (12.83, 18.08 $plant^{-1}$) respectively.

A similar result was in close agreement with the finding were reported by Saini *et al.*, (1976) and Tripathy *et al.*, (1999) who stated that the number of root nodules increase with increase in iron and zinc content in the soil because iron increase the leg hemoglobin production in nodules and also promote growth of nodules.

Table.1 Effect of different sources and levels of chelated iron and zinc on the height of summer groundnut

Treatments	Height (cm)			
	30 DAS (cm)	60 DAS (cm)	90 DAS (cm)	At Harvest (cm)
Factor A				
S_0 :100% RDF	9.49	18.2	21.52	22.93
S_1: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1}	9.79	18.38	21.72	24.18
S_2: 100% RDF + FeEDDHA @ 1.5 kg ha^{-1}	9.54	19.88	22.00	23.80
S_3: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}	10.51	20.38	22.78	25.78
F′ test	NS	NS	NS	NS
SE(m) ±	0.422	0.538	0.588	0.448
CD at 5%	-	-	-	-
Factor B				
F_0:FA of water	9.80	19.02	20.88	21.91
F_1: FA @ 0.5 % Zn EDTA (35 DAS, 65 DAS)	9.86	19.68	21.98	23.48
F_2: FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	9.87	19.88	21.78	22.43
F_3: FA @ 0.5 % Zn EDTA + FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	11.43	19.97	22.83	25.32
F′ test	NS	NS	NS	NS
SE(m) ±	0.422	0.538	0.588	0.448
CD at 5%	-	-	-	-
INTERACTION (S×F)				
F′ test	NS	NS	NS	NS
SE(m) ±	0.844	1.076	1.176	0.897
CD at 5%	-	-	-	-

Effect of foliar spray

The effect of foliar spray of chelated zinc and iron on the number of root nodules was found statistically significant for 60 DAS and at harvest. The average maximum number of root nodules was recorded in F_3 (Zn EDTA @ 0.5 % + FeEDDHA @ 1.0 % at 35 and 65 DAS) (71.25, 20.67 plant^{-1}) which was at par (57.25, 19.75 plant^{-1}) with F_2 (FeEDDHA @ 1.0 % at 35 and 65 DAS). The minimum number of root nodules was recorded in F_0 (Foliar spray of water) (51.75, 18.67 plant^{-1} respectively).

A similar result was in close agreement with the finding were reported by Saini *et al.*, (1976) and Tripathy *et al.*, (1999) who stated that the number of root nodules increase with increase in iron and zinc content in the soil because iron increase the leg hemoglobin production in nodules and also promote growth of nodules.

Effect of Interactions

The interaction effect of soil application and foliar spray of chelated zinc and iron on the number of root nodules of the summer groundnut was found to be statistically non-significant.

Table.2 Effect of different sources and levels of chelated iron and zinc on number of root nodules of summer groundnut

Treatments	No. of root nodules			
	30 DAS	60 DAS	90 DAS	At Harvest
Factor A				
S_0 : 100% RDF	12.83	57.58	21.00	18.08
S_1: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1}	13.58	58.58	22.67	19.17
S_2: 100% RDF + FeEDDHA @ 1.5 kg ha^{-1}	15.00	58.42	22.83	19.33
S_3: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}	16.5	66.42	23.08	21.58
F′ test	S	NS	NS	S
SE(m) ±	0.808	2.518	0.576	0.381
CD at 5%	2.335	-	-	1.101
Factor B				
F_0:FA of water	12.75	51.75	21.75	18.67
F_1: FA @ 0.5 % Zn EDTA (35 DAS, 65 DAS)	14.58	57.17	22.00	19.17
F_2: FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	14.42	57.25	22.17	19.75
F_3: FA @ 0.5 % Zn EDTA + FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	15.25	71.25	23.08	20.67
F′ test	NS	S	NS	S
SE(m) ±	0.808	2.518	0.576	0.381
CD at 5%	-	7.271		1.101
INTERACTION (S×F)				
F′ test	NS	NS	NS	NS
SE(m) ±	1.617	5.035	1.152	0.763
CD at 5%	-	-	-	-

Yield

The data regarding the pod and haulm yield of summer groundnut influenced by the soil and foliar application of chelated iron and zinc fertilizers was recorded at harvest and presented in Table 3.

Effect of soil application

The effect of soil application of chelated zinc and iron on the pod and haulm yield of summer groundnut were found to be statistically significant. The significantly highest pod yield of summer groundnut was recorded in S_3 (100% (RDF) + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) (39.68 q ha^{-1}), which was statistically at par with S_2 (100% RDF + FeEDDHA @ 1.5 kg ha^{-1}) (35.61 q ha^{-1}) and minimum pod yield was recorded on S_0 (100% RDF) (33.60 q ha^{-1}). The significantly highest haulm yield of summer groundnut was recorded in S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) (57.26 q ha^{-1}) which was statistically at par with S_2 (100% RDF + FeEDDHA @ 1.5 kg ha^{-1}) (46.07 q ha^{-1}) and minimum pod yield was recorded on S_0 (100% RDF) (43.18 q ha^{-1}).

Table.3 Effect of different sources and levels of chelated iron and zinc on pod and haulm yield of summer groundnut

Treatments	Yield (q ha^{-1})	
	Pod yield	**Haulm yield**
Factor A		
S_0 :100% (RDF)	33.60	43.18
S_1: 100% (RDF) + Zn EDTA @ 1.5 kg ha^{-1}	35.55	45.62
S_2: 100%(RDF) + FeEDDHA @ 1.5 kg ha^{-1}	35.61	46.07
S_3: 100% (RDF) + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}	39.68	57.26
F′ test	S	S
SE(m) ±	0.371	0.029
CD at 5%	1.07	0.084
Factor B		
F_0:FA of water	34.82	45.52
F_1: FA @ 0.5 % Zn EDTA (35 DAS, 65 DAS)	35.68	47.35
F_2: FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	36.42	47.77
F_3: FA @ 0.5 % Zn EDTA + FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	37.58	50.30
F′ test	S	S
SE(m) ±	0.371	0.029
CD at 5%	1.07	0.084
INTERACTION (S×F)		
F′ test	S	S
SE(m) ±	0.743	0.058
CD at 5%	2.23	0.168
CV	8.98	11.26

A similar result was in close agreement with the finding were reported by Lachover *et al.,* (1970) and Ali and Mowafy (2003) and Singh and Maan (2007) who reported the increase in the pod and haulm yield because iron and zinc increase the chlorophyll and enzymatic activity which had a great importance in photosynthesis and respiration.

Effect of foliar spray

The effect of foliar spray of chelated zinc and iron on the pod and haulm yield of summer groundnut were found statistically significant. The significantly highest pod yield of summer groundnut was recorded in F_3 (Zn EDTA @ 0.5 % + FeEDDHA @ 1.0% at 35 and 65 DAS) (37.58 q ha^{-1}), which was statistically at par with F_2 (FeEDDHA @ 1.0 % at 35 and 65 DAS) (36.42 q ha^{-1}) and minimum pod yield was recorded in F_0 (Foliar spray of water) (34.82 q ha^{-1}).

The significantly highest haulm yield of summer groundnut was recorded in F_3 (Zn EDTA @ 0.5% + FeEDDHA @ 1.0% at 35 and 65 DAS) (50.30 q ha^{-1}), which was statistically at par with F_2 (FeEDDHA @ 1.0% at 35 and 65 DAS) (47.77 q ha^{-1}) and minimum haulm yield was recorded in F_0 (Foliar spray of water) (45.52 q ha^{-1}) respectively.

The finding were reported by Singh and Sahu (1993); Ali and Mowafy (2003) and Singh and Maan (2007) who reported the increase in the haulm yield because iron and zinc increase the chlorophyll and enzymatic activity which had a great importance in photosynthesis and respiration.

Effect of interaction

The interaction effect of soil and foliar spray of chelated zinc and iron on pod and haulm yield was statistically significant and the data is given in Table 3a and 3b. The highest pod (42.48 q ha^{-1}) and haulm yield (63.11q ha^{-1}) was recorded in S_3F_3 and lowest pod yield (32.69 q ha^{-1}) and haulm yield (42.22 q ha^{-1}) was recorded in S_0F_0.

100 kernel weight and shelling percentage

The data regarding the 100 kernel weight and shelling percentage in plant as influenced by soil and foliar spray of chelated iron and zinc was presented in Table 4.

Table.3a Interaction effect of soil application and foliar spray of chelated zinc and iron on the pod yield (q ha^{-1}) of summer groundnut

Treatments	Foliar spray				
Soil app.	**F_0**	**F_1**	**F_2**	**F_3**	**Mean**
S_0	32.69	33.23	33.70	34.79	33.60
S_1	34.70	35.27	35.87	36.35	35.55
S_2	34.83	35.05	35.87	36.68	35.61
S_3	37.07	35.05	40.02	42.48	39.68
Mean	34.82	35.68	36.36	37.58	
	F' test		**SE (m)±**		**CD at 5%**
(S)	S		0.371		1.072
(F)	S		0.371		1.0725
(S×F)	S		0.743		2.146

Table.3b Interaction effect of soil application and foliar spray of chelated zinc and iron on the haulm yield (qha^{-1}) of summer groundnut

Treatments	Foliar spray				
Soil app.	**F_0**	**F_1**	**F_2**	**F_3**	**Mean**
S_0	42.22	43.08	43.88	43.53	43.18
S_1	43.42	45.62	46.42	47.02	45.62
S_2	45.03	45.36	46.36	47.51	46.07
S_3	51.44	55.33	59.21	63.11	57.26
Mean	45.52	47.35	48.97	50.30	
	F' test		**SE (m)±**	**CD at 5%**	
(S)	S		0.029	0.0843	
(F)	S		0.029	0.0843	
(S×F)	S		0.0583	0.1684	

Table.4 Effect of different sources and levels of chelated iron and zinc on 100 kernel weight and shelling percentage of summer groundnut.

Treatments	100 kernel weight (g)	Shelling %
Factor A		
S_0 :100% RDF	45.22	64.69
S_1: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1}	47.42	67.68
S_2: 100% RDF + FeEDDHA @ 1.5 kg ha^{-1}	47.57	69.47
S_3: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}	49.12	71.42
F′ test	NS	NS
SE(m)±	0.16	4.47
CD at 5%	-	-
Factor B		
F_0:FA of water	46.32	67.02
F_1: FA @ 0.5 % Zn EDTA (35 DAS, 65 DAS)	47.24	67.54
F_2: FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	47.13	67.49
F_3: FA @ 0.5 % Zn EDTA + FA @ 1.0 % Fe EDDHA (35 DAS, 65 DAS)	48.30	70.10
F′ test	NS	NS
SE(m)±	0.16	4.47
CD at 5%	-	-
INTERACTION (S×F)		
F′ test	NS	NS
SE(m)±	0.32	8.93
CD at 5%	-	-

Effect of Soil application

The effect of soil application of chelated iron and zinc on the 100 kernel weight and shelling percentage was found to be statically non-significant. The maximum average 100 kernel weight and shelling percentage were recorded in S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) (49.12 g, 71.42%), which was at par with S_2 (100% RDF + FeEDDHA @ 1.5 kg ha^{-1}) (47.57 g, 69.47%). The minimum 100 kernel weight and shelling percentage was recorded in S_0 (100% RDF) (45.22 g, 64.69%) respectively.

A similar result was in close agreement with the finding were reported by Marious *et al.,* (2011) and Der *et al.,* (2015) who stated the increase in the 100 kernel weight and shelling percentage due to application of Fe and Zn because iron and zinc leads to increase in photosynthesis on one hand and on the other hand its leads to greater mobilization of photosynthates to reproductive structures which leads to increase in pod and kernel yield.

Effect of foliar spray

The effect of foliar spray of chelated zinc and iron on 100 kernel weight and shelling percentage were found statistically non-significant. The average maximum 100 kernel weight and shelling percentage was recorded in F_3(@ 0.5%Zn EDTA+ @ 1.0 % FeEDDHA at 35 and 65 DAS) (48.30 g, 70.10%) which was at par with F_1 (ZnEDTA @ 0.5% Zn EDTA at 35 and 65 DAS) (47.24 g, 67.54% respectively). The minimum100 kernel weight and shelling percentage was recorded in F_0 (Foliar spray of water) (46.32 g, 67.02%), respectively. A similar result was in close agreement with the finding were reported by Marious *et al.,* (2011) and Der *et al.,* (2015) who stated the increase in the 100 kernel weight and shelling percentage content due to application of Fe and Zn because iron and zinc leads to increase in photosynthesis on one hand and on the other hand its leads to greater mobilization of photosynthates to reproductive structures which leads to increase in pod and kernel yield.

Effect of Interactions

The interaction effect of soil application and foliar spray of chelated iron and zinc on the 100 kernel weight and shelling percentage of the summer groundnut was found to be statistically non-significant; hence the results regarding interaction effect on the above said parameter are not discussed.

The results of the present investigation revealed that, the yield (Pod and Haulm) of summer groundnut was significantly highest with Soil application of chelated zinc and iron(S_3 : Control (RDF) + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) is 39.68 qha^{-1} pod yield, 57.26 qha^{-1} haulm yield and along with foliar spray of chelated zinc and iron (F_3 : Zn EDTA @ 0.5 % + FeEDDHA @ 1.0% at 35 and 65 DAS) is 37.658 qha^{-1} pod yield 50.30 qha^{-1} haulm yield. The growth parameters like height of summer groundnut, number of nodules, 100 kernel weight and Shelling % were non-significant. So, it can be concluded that the nutrient management in the groundnut with soil application (S_3: Control (RDF) + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}) along with foliar spray of chelated iron and zinc (F_3: Zn EDTA @ 0.5 % + FeEDDHA @ 1.0% at 35 and 65 DAS) was found to be most effective in increasing the yield of groundnut.

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