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Effect of chelated zinc and iron on the uptake and quality parameters of summer groundnut (*Arachis hypogaea* L.)

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Abstract
The field experiment entitled Effect of Chelated zinc and iron on Summer Groundnut of uptake and quality parameters 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 (Zn EDTA and Fe EDDHA) replicated three times. The results of the present investigation revealed that, the uptake of N, P, K, Zn, Fe, Cu and Mn of summer groundnut was significantly highest with Soil application of chelated zinc and iron S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + Fe EDDHA @ 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). The highest protein and oil content is in Soil application of chelated zinc and iron S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + Fe EDDHA @ 1.5 kg ha^{-1}) along with foliar spray of chelated iron and zinc F_3 (Zn EDTA @ 0.5% + Fe EDDHA @ 1.0% at 35 and 65 DAS) and this was non -significant among the treatments.

Keywords: Chelated micronutrients (Fe EDDHA, Zn EDTA), uptake, protein content, oil content

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 inter-venial 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. A chelate 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 uptake and quality parameters of Summer Groundnut (*Arachis hypogaea* L.)

Materials and Methods

The experiment entitled Effect of Chelated zinc and iron on the uptake and quality parameters of Summer Groundnut (*Arachis hypogaea* L.) was carried out during the summer 2022-23 at Oilseeds 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.

Results and Discussion

Uptake of macronutrients

The data regarding uptake of primary nutrients as influenced by soil and foliar spray of chelated zinc and iron was presented in Table 1.

Effect of Soil application

The effect of soil application of chelated zinc and iron on nitrogen, phosphorus, potassium and sulphur uptake was found to be statistically significant. The maximum average nitrogen, phosphorus, potassium and sulphur uptake was recorded in S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + Fe EDDHA @ 1.5 kg ha^{-1}) (228.74, 22.56, 49.63, 17.84 kg ha^{-1}), which was at par with S_2 (100% RDF + Fe EDDHA @ 1.5 kg ha^{-1}) (223.11, 20.69, 46.04, 14.92 kg ha^{-1}). The minimum nitrogen, phosphorus, potassium and sulphur uptake was recorded in S_0 (100% RDF) (185.70, 19.70, 38.95, 13.47 kg ha^{-1}) respectively. A similar result was in close agreement with the finding were reported by Nassar *et al*., (1997) [5], Singaravel *et al*., (2006) [8] and Damor *et al*., (2019) [1] who stated the increased uptake of nitrogen, phosphorus, potassium and sulphur with increase in application of chelated Fe and Zn as iron and zinc increase the activity of enzymes which increase the nutrient absorption of nutrients.

Effect of foliar spray

The effect of foliar spray of chelated iron and zinc on the uptake of nitrogen, phosphorus, potassium and sulphur uptake were found to be statistically significant. The average maximum nitrogen, phosphors, potassium and sulphur uptake were recorded in F_3 (Zn EDTA @ 0.5% + Fe EDDHA @ 1.0% at 35 and 65 DAS) (227.05, 22.10, 47.46, 16.47 kg ha^{-1}) which was at par with F_2 (Fe EDDHA @ 1.0% at 35 and 65 DAS) (223.15, 20.90, 43.62, 15.41 kg ha^{-1}). The minimum nitrogen, phosphorus, potassium and su uptake was recorded in F_0 (Foliar spray of water) (175.62, 20.02, 42.20, 13.92 kg ha^{-1}), respectively. A similar result was in close agreement with the finding were reported by Nassar *et al*., (1997) [5], Singaravel *et al*., (2006) [8] and Domar *et al*., (2019) [1] who stated the increased uptake of nitrogen, phosphorus, potassium and sulphur with increase in application of chelated Fe and Zn as iron and zinc increase the activity of enzymes which increase the nutrient absorption of nutrients.

Effect of Interactions

The interaction effect of soil application and foliar spray of chelated zinc and iron on the nitrogen, phosphorus, potassium and sulphur uptake of the summer groundnut was found to be statistically significant so the interaction effect for nitrogen, phosphorus, potassium and sulphur uptake. It was recorded minimum in S_0F_0 and maximum in S_3F_3.

Uptake of micronutrients

The data regarding the uptake of micronutrients (Zn, Fe, Mn, Cu) as influenced by soil application and foliar spray of chelated zinc and iron was presented in Table 2.

Effect of Soil application

The effect of soil application on the uptake of micronutrient (Zn, Fe, Mn, Cu) was found to be statistically significant. The maximum (Zn, Fe, Mn, Cu) uptake was recorded in S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + Fe EDDHA @ 1.5 kg ha^{-1}) (189, 3028, 602,203 g ha^{-1}), which was at par with S_1 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1}) (187, 585, 184 g ha^{-1}) for Zn, Mn, and Cu respectively and S_2 (100% RDF + Fe EDDHA @ 1.5 kg ha^{-1}) for Fe (2253 g ha^{-1}). The minimum uptake of micronutrients uptake was recorded in S_0 (100% RDF (165, 1513, 523, 170 g ha^{-1}) respectively. A similar result was in close agreement with the finding were reported by Yilmaz *et al*., (1997) [11], Patel *et al*., (2016) [6] and Elayaraja and Senthivalavan (2019) [2] who stated the increased uptake of micronutrients with increase in application of chelated Fe and Zn.

Effect of foliar spray

The effect of foliar spray on the uptake of micronutrients (Zn, Fe, Mn, Cu) was found to be statistically significant. The average maximum micronutrient uptake were recorded in F_3 (Zn EDTA @ 0.5% + Fe EDDHA @ 1.0% at 35 and 65 DAS) (187, 2516, 599,194 g ha^{-1}) which was at par with F_2 (Fe EDDHA @ 1.0% at 35 and 65 DAS) (1984, 566 g ha^{-1}) for Fe and Mn and F_1 (Zn EDTA @ 0.5% at 35 and 65 DAS) (178 and 179 g ha^{-1}) for Zn and Cu. The minimum micronutrient (Zn, Fe, Mn, Cu) uptake was recorded in F_0 (Foliar spray of water) (173, 1646, 558,155 gha^{-1}), respectively.

A similar result was in close agreement with the finding were reported by Yilmaz *et al*., (1997) [11], Lokhande *et al*., (1998) [3], Patel *et al*., (2016) [6] and Elayaraja and Senthivalavan (2019) [2] who stated the increased uptake of micronutrients with increase in application of chelated Fe and Zn.

Effect of Interactions

The interaction effect of soil application and foliar spray of chelated zinc and iron on the micronutrients (Zn, Fe, Mn, Cu) uptake of the summer groundnut was found to be statistically significant. It was recorded minimum in S_0F_0 and maximum in S_3F_3.

c) Quality parameters

The data regarding the quality parameters of summer groundnut as influenced by soil and foliar spray of chelated iron and zinc was presented in Table 3.

Effect of Soil application

The effect of soil application of chelated zinc and iron on protein and oil content was found to be statistically non-significant. The maximum protein and oil content was recorded in S_3 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + Fe EDDHA @ 1.5 kg ha^{-1})

(25.25%, 49.03%), which was at par with S_1 (100% RDF + Zn EDTA @ 1.5 kg ha^{-1}) (24.78%, 47.45%). The minimum protein and oil content was recorded in S_0 (100% RDF (23.61%, 45.94%) respectively.

A similar result was in close agreement with the finding were reported by Moussa *et al*., (1998) [4], Singh and Basu (2004) [9], Tathe *et al*., (2008) [10], Reddy *et al*., (2011) [7] who stated the increased protein and carbohydrate content with the application of chelated Fe and Zn.

Effect of foliar spray

The effect of foliar spray of chelated zinc and iron on the protein and oil content was found to be statistically non-significant. The average maximum protein and oil content were recorded in F_3 (Zn EDTA @ 0.5% + Fe EDDHA @ 1.0% at 35 and 65 DAS) (25.38%, 49.06%) which was at par with F_1 (Zn EDTA @ 0.5% at 35 and 65 DAS) (24.90%, 46.99%). The minimum protein and oil content was recorded in F_0 (Foliar spray of water) (23.89%, 45.35%), respectively. A similar result was in close agreement with the finding were reported by Moussa *et al*., (1998) [4], Singh and Basu (2004) [9], Tathe *et al*., (2008) [10], Reddy *et al*., (2011) [7] who stated the increased protein, carbohydrate and oil content with the application of chelated Fe and Zn.

Effect of Interactions

The interaction effect of soil application and foliar spray of chelated zinc and iron on protein content and oil content were found to be statistically non-significant. It is numerically greater recorded minimum in S_0F_0 and maximum in S_3F_3.

Table 1: Effect of different sources and levels of chelated zinc and iron on uptake of macronutrients in summer groundnut.

Treatments	Uptake of macronutrients (kg ha^{-1})			
	Nitrogen	Phosphorus	Potassium	Sulphur
Factor A				
S_0: 100% RDF	185.70	19.70	38.95	13.47
S_1: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1}	222.38	20.58	43.87	14.86
S_2: 100% RDF + FeEDDHA @ 1.5 kg ha^{-1}	223.11	20.69	46.04	14.92
S_3: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}	228.74	22.56	49.63	17.84
F′ test	S	S	S	S
SE(m)±	14.91	0.406	0.672	0.315
CD at 5%	42.73	1.173	1.941	0.909
Factor B				
F_0:FA of water	175.62	20.02	42.20	13.92
F_1: FA @ 0.5% Zn EDTA (35 DAS, 65 DAS)	222.97	20.69	43.48	14.84
F_2: FA @ 1.0% Fe EDDHA (35 DAS, 65 DAS)	223.15	20.90	43.62	15.41
F_3: FA @ 0.5% Zn EDTA + FA @ 1.0% Fe EDDHA (35 DAS, 65 DAS)	227.05	22.10	47.46	16.47
F′ test	S	S	S	S
SE(m) ±	14.91	0.406	0.672	0.315
CD at 5%	43.73	1.173	1.941	0.909
Interaction (S×F)				
F′ test	S	S	S	S
SE(m) ±	29.821	0.674	1.344	0.63
CD at 5%	86.116	1.983	3.962	1.818

Table 2: Effect of different sources and levels of chelated zinc and iron on uptake of micronutrients in summer groundnut

Treatments	Uptake of Micronutrients (g ha^{-1})			
	Zn	Fe	Mn	Cu
Factor A				
S_0: 100% RDF	155	1513	523	170
S_1: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1}	187	1680	585	184
S_2: 100% RDF + FeEDDHA @ 1.5 kg ha^{-1}	169	2253	581	179
S_3: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}	189	3029	602	203
F′ test	S	S	S	S
SE(m) ±	11.638	26.952	4.612	2.497
CD at 5%	32.89	77.834	13.318	7.211
Factor B				
F_0:FA of water	173	1646	558	155
F_1: FA @ 0.5% Zn EDTA (35 DAS, 65 DAS)	178	1911	563	179
F_2: FA @ 1.0% Fe EDDHA (35 DAS, 65 DAS)	177	1984	566	157
F_3: FA @ 0.5% Zn EDTA + FA @ 1.0% Fe EDDHA (35 DAS, 65 DAS)	187	2516	599	194
F′ test	S	S	S	S
SE(m) ±	11.638	26.952	4.612	4.994
CD at 5%	32.89	77.834	13.318	14.422
Interaction (S×F)				
F′ test	S	S	S	S
SE(m) ±	23.276	53.905	9.224	31.429
CD at 5%	67.218	155.668	26.636	90.762

Table 3: Effect of different sources and levels of chelated iron and zinc on the quality parameters of summer groundnut

Treatments	Protein Content (%)	Oil Content (%)
Factor A		
S_0: 100% RDF	23.61	45.94
S_1: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1}	24.78	47.45
S_2: 100% RDF + FeEDDHA @ 1.5 kg ha^{-1}	24.63	46.60
S_3: 100% RDF + Zn EDTA @ 1.5 kg ha^{-1} + FeEDDHA @ 1.5 kg ha^{-1}	25.25	49.03
F′ test	NS	NS
SE(m) ±	0.173	0.264
CD at 5%	-	-
Factor B		
F_0:FA of water	23.89	45.35
F_1: FA @ 0.5% Zn EDTA (35 DAS, 65 DAS)	24.90	46.99
F_2: FA @ 1.0% Fe EDDHA (35 DAS, 65 DAS)	24.54	46.83
F_3: FA @ 0.5% Zn EDTA + FA @ 1.0% Fe EDDHA (35 DAS, 65 DAS)	25.38	49.06
F′ test	NS	NS
SE(m) ±	0.173	0.264
CD at 5%	-	-
Interaction (S×F)		
F′ test	NS	NS
SE(m) ±	0.34	0.528
CD at 5%	-	-

Conclusion

From the present investigation, it can be concluded that, the soil application of (100% RDF+ Zn EDTA @ 1.5 kg ha^{-1} + Fe EDDHA @ 1.5 kg ha^{-1}) and foliar application of (Zn EDTA @ 0.5% + Fe EDDHA @ 1.0% at 35 and 65 DAS) were found equally beneficial for quality parameters and nutrient uptake as well as fertility status of soil under Groundnut.

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