Original Research Article

Effect of macro and micronutrients on nutrient uptake of groundnut (*Arachis hypogaea* L.) in coastal sandy soils

Abstract

A field experiment was conducted at Agricultural College Farm, Bapatla during *rabi*, 2021-22 to assess the response of macro and micronutrients on nutrient uptake of groundnut in coastal sandy soil. The results of the experiment clearly indicated that the nutrient uptake of macro, secondary and micronutrients was significantly influenced by the application of macro and micronutrients. The treatment T_5 (125% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}) recorded significantly higher uptake of N, P, K, S, Fe, Zn, Cu, Mn and B at peg penetration stage. At pod development stage except iron, the highest values of N, P, K, S, Zn, Cu, Mn and B uptake were recorded in the treatment T_5 and it was on par with the treatment T_7. The treatment T_7 which received 125% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS registered the highest uptake of N, P, K, S, Zn, Cu, Mn and B but on par with T_5 at harvest stage. For iron uptake at pod development and harvest stage, the treatment T_7 obtained significantly higher values and it was significantly superior over all other treatments.

Keywords: Groundnut; Micronutrients; Uptake; Zinc; Boron; Iron.

Introduction

Groundnut (*Arachis hypogeae* L.) is one of the important oilseed crops and occupies an important position in the Indian agricultural economy. It is capable of fixing atmospheric nitrogen by the bacteria *Rhizobium* present in the nodules and hence it requires less N containing fertilizers. It contains high oil and protein content hence it is called as the king of oil seed crops. India ranks first in groundnut area with an area of 4.89 million hectares and second in production with 10.10 million tonnes. It is a rich source of edible oil and high quality protein and hence it is valued for both oil and confectionary purposes. Groundnut is mainly grown for its seed but all parts of the plant are utilized [11].

Groundnut is mostly grown in light textured soils especially sandy loam and sandy soils mainly because it has underground pod bearing habit. But these soils have poor nutrient status especially micronutrients, zinc (Zn) and boron (B) due to leaching, low nutrient retention capacity and low organic matter status [6]. Restricted availability of these nutrients in sandy soil greatly impairs the yield of groundnut. Judicious use of fertilizer is an important management practice to increase groundnut production. Balanced use of fertilizers assumes vital important in sustainable agriculture. In these soils, the nutrient uptake will also be low, if unfertilized. Improvement in uptake of macro and micronutrients by the application of micronutrients has been reported by several workers. Keeping all these points in view, this experiment was conducted to evaluate the effect of macro and micronutrients on nutrient uptake of groundnut in coastal sandy soils.

Materials and Methods

The experiment was carried out during *rabi,* 2021-22 at Agricultural College Farm, Bapatla in RBD with seven treatments replicated thrice. The experimental soil was sandy in texture, neutral in reaction (6.65), non-saline (0.09 dS m^{-1}), low in organic carbon (0.09 g kg^{-1}), available nitrogen (135 kg ha^{-1}), medium in available phosphorus (39.5 kg ha^{-1}) and low in available potassium (118 kg ha^{-1}), calcium (320 mg kg^{-1}) and magnesium (42 mg kg^{-1}) and sufficient in sulphur (20 mg kg^{-1}), manganese (3.59 mg kg^{-1}), copper (0.69 mg kg^{-1}) and deficient in boron (0.29 mg kg^{-1}), iron (3.95 mg kg^{-1}) and zinc (0.29 mg kg^{-1}). The treatments are T_1- Control, T_2- 100% RDF, T_3- 125% RDF, T_4- 100% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}, T_5- 125% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}, T_6- 100% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS, T_7- 125% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS. A common dose of 30 kg nitrogen ha^{-1}, was applied through urea in two equal split doses, half as basal, and a half at 30 DAS by considering the plot size. A common dose of phosphorus @ 40 kg ha^{-1} in the form of single super phosphate, and potassium @ 50 kg ha^{-1} in the form of muriate of potash were applied as basal before sowing. $ZnSO_4$ and borax were applied at the rate of 50 kg ha^{-1} and 10 kg ha^{-1} respectively, to the plots as per the treatments as basal and foliar application of $ZnSO_4$, $FeSO_4$ and borax were applied at the rate of 2 g L^{-1}, 5 g L^{-1} and 1.5 g L^{-1} at 45 DAS and 65 DAS to the respective plots as per the treatments.

The groundnut variety TAG-24 was planted in the second week of November with a spacing of 30 x 10 cm. The crop was raised with all the standard packages of practices as they required. Plant samples were collected at peg penetration, pod development and harvest stages and analyzed using standard procedures in the laboratory. Five representative plant samples were collected, shade dried and kept in oven at 70^0 C for 24 to 48 hours till the constant weight and then it was averaged to get data in g/ plant, then calculated on hectare basis. Plant uptakes were worked out by using nutrient content and dry matter accumulation. The data were analyzed statistically by following the analysis of variance (ANOVA) technique as suggested by Panse and Sukhatme (1978) for RBD.

Macronutrient uptake (kg ha^{-1}) = (Nutrient concentration (%) × Dry matter yield (kg ha^{-1}))/100

Micronutrient uptake (g ha^{-1}) = (Nutrient concentration (mg kg^{-1}) × Dry matter yield (kg ha^{-1})) / 1000

Results and Discussion

Macronutrients Uptake

Application of macro and micronutrient had a significant influence on macronutrients uptake by the groundnut at all the stages of the crop (Table 1). The highest N(52.61 kg ha^{-1}), P(8.59 kg ha^{-1}) and K(41.5 kg ha^{-1}) uptakes were recorded by the treatments T_5 (125% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}) at peg penetration stage. Whereas at pod development stage, the treatment T_5 recorded the highest uptake of N(61.45 kg ha^{-1}), P(11.47 kg ha^{-1}) and K(46.3 kg ha^{-1}) but it was on par with T_7. In haulm and kernel at harvest stage, the highest N(30.95 and 92.95 kg ha^{-1}), P(4.22 and 8.94 kg ha^{-1}) and K(33.1 and 22.8 kg ha^{-1}) uptakes respectively, were recorded by the treatment T_7 which received 125% RDF + Foliar application of Zn, Fe and B at 45 and 65 DAS) and it was on par with T_5. The lowest uptake of all macronutrients (N, P and K) was recorded in the control (T_1) at all the stages. Yakadri and Satyanarayana [14] reported that there is a close relationship between nutrient uptake and dry matter production in groundnut. The increased uptake of nitrogen was mainly due to the fact that the micronutrients like zinc and boron are involved in nitrogen fixation and translocation into plant parts, which might have led to higher dry matter production. The higher uptake might be due to the solubilization of native phosphorus in addition to applied fertilizers which ultimately resulted in better root growth and increased physiological activity of roots to absorb more phosphorus (Sudarasan and Ramaswami [12]; Sumangala [13]). Increased K uptake might be due to better plant growth leading to higher uptake of nutrients and further on the stimulatory effect of B and Zn in absorption of potassium. Such findings were in accordance in Elayaraja and Singaravel [5], Abd EL-Kader and Mona [1] and Abhigna [2].

Treatments	Nitrogen uptake (kg ha^{-1})				Phosphorus uptake (kg ha^{-1})				Potassium uptake (kg ha^{-1})			
	PP	PD	Harvest		PP	PD	Harvest		PP	PD	Harvest	
			Haulm	Kernel			Haulm	Kernel			Haulm	Kernel
T_1: Control	23.70	27.26	12.12	35.69	4.00	5.41	1.70	3.51	19.2	21.2	14.0	8.8
T_2: 100% RDF	32.06	36.95	17.06	53.41	5.38	7.24	2.44	5.32	25.5	28.4	19.3	12.9
T_3: 125% RDF	42.33	48.48	23.52	72.63	7.12	9.36	3.28	7.15	33.1	36.8	25.5	17.9
T_4: 100% RDF + Soil application of $ZnSO_4$ @ 50kg ha^{-1} and Borax @ 10 kg ha^{-1}	41.42	47.90	22.59	71.78	7.06	9.21	3.30	7.00	33.0	36.5	25.4	17.7
T_5: 125% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}	52.61	61.45	30.45	92.13	8.59	11.47	4.08	8.83	41.5	46.3	32.9	22.7
T_6: 100% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS	32.89	47.41	22.88	72.05	5.52	9.18	3.24	7.08	26.0	36.2	25.4	17.8
T_7: 125% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS	42.33	60.52	30.95	92.95	7.03	11.46	4.22	8.94	33.0	46.0	33.1	22.8
SEm (±)	1.71	2.72	1.11	3.74	0.24	0.39	0.14	0.38	1.86	2.20	0.99	0.81
CD (p=0.05)	5.27	8.38	3.43	11.53	0.74	1.22	0.42	1.17	5.73	6.77	3.06	2.50
CV (%)	7.76	9.99	8.46	9.25	6.52	7.55	7.45	9.63	10.67	10.59	6.85	8.16

Table 1. Effect of macro and micronutrients on N, P and K uptake by groundnut

(PP-Peg penetration stage, PD- Pod development Stage)

Secondary and micronutrients uptake

Perusal of data revealed that there was a significant influence of secondary and micronutrients uptake at all the stages by the macro and micronutrient application (Table 2 and 3). Maximum sulphur uptake(7.07 kg ha^{-1}) was recorded with the treatment T_5 at peg penetration stage. At pod development stage, the treatment T_5 recorded maximum sulphur uptake(10.09 kg ha^{-1}) and it was on par with T_7. Whereas at harvest stage, the treatment T_7 obtained the highest uptake in both haulm(6.06 kg ha^{-1}) and kernel(5.69 kg ha^{-1}) which was on par with T_5 (Table 2). The higher sulphur uptake might also be due to stimulatory effect of zinc and boron uptake.

Highest iron(393 g ha^{-1}) uptake was recorded with the treatment T_5 (125% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}) at peg penetration stage. At pod development and haulm and kernel at harvest stages, highest iron uptake of 505, 284 and 224 g ha^{-1} were recorded with the treatment T_7 (125% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS) and it was superior over all other treatments.

At peg penetration stage, maximum Zn(119.3 g ha^{-1}), Cu(27.00 g ha^{-1}), Mn(116.0 g ha^{-1}) and B(90.9 g ha^{-1}) uptake was recorded with the treatment T_5. The treatment T_5 recorded significantly higher uptake of Zn(147.0 g ha^{-1}), Cu(36.27 g ha^{-1}), Mn(135.9 g ha^{-1}) and B(142.4 g ha^{-1}) at pod development stage and it was on par with T_7. At harvest stage, the treatment T_7 obtained the maximum uptake of Zn(84.8 and 57.9 g ha^{-1}), Cu(24.48 and 19.34 g ha^{-1}), Mn(91.2 and 57.8 g ha^{-1}) and B(95.9 and 70.6 g ha^{-1}) in both haulm and kernel respectively and this was statistically on par with T_5. The lowest uptake of all micronutrients at all the stages was recorded by the treatment T_1 (Control).

Both soil and foliar application of micronutrients led to an increase in the concentrations of macro and micronutrients in seeds due to the vital physiological roles in the plants which promotes the uptake of plant nutrients. Increase in micronutrients uptake might also be due to higher dry matter production coupled with increased content. Also, a positive interaction between iron, boron and zinc was also reported [8]. The results are in accordance with Gowthami and Ananda [7], Aboyeji *et al.* [3], Elayaraja and Senthilvalavan[4] and Kamalakannan and Elayaraja (2020)[9].

Table 2. Effect of macro and micronutrients on S, Fe and Zn uptake by groundnut

Treatments	Sulphur uptake (kg ha^{-1})				Iron uptake (g ha^{-1})				Zinc uptake (g ha^{-1})			
	PP	PD	Harvest		PP	PD	Harvest		PP	PD	Harvest	
			Haulm	Kernel			Haulm	Kernel			Haulm	Kernel
T_1: Control	3.64	4.99	2.73	2.43	210	241	115	86	58.5	66.7	35.7	22.3
T_2: 100% RDF	4.50	6.23	3.56	3.41	255	282	139	114	71.4	82.8	45.4	30.7
T_3: 125% RDF	5.34	7.38	4.38	4.16	303	325	163	136	83.4	97.6	54.5	37.1
T_4: 100% RDF + Soil application of $ZnSO_4$ @ 50kg ha^{-1} and Borax @ 10 kg ha^{-1}	6.15	8.56	5.15	4.86	347	369	201	157	107.0	130.2	72.3	48.6
T_5: 125% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}	7.07	10.09	6.04	5.64	393	411	227	178	119.3	147.0	83.8	56.7
T_6: 100% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS	4.59	8.47	5.00	4.90	258	451	249	197	71.9	129.9	72.5	49.3
T_7: 125% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS	5.44	9.76	6.06	5.69	303	505	284	224	83.3	145.3	84.8	57.9
SEm (±)	0.25	0.37	0.26	0.19	13.84	12.98	7.12	6.23	3.82	4.39	2.88	1.90
CD (p=0.05)	0.76	1.13	0.79	0.60	42.65	39.99	21.93	19.19	11.77	13.54	8.87	5.85
CV (%)	8.09	7.98	9.41	7.59	8.11	6.09	6.26	6.92	7.79	6.66	7.78	7.60

(PP-Peg Penetration Stage, PD-Pod Development Stage)

Treatments	Copper uptake (g ha^{-1})				Manganese uptake (g ha^{-1})				Boron uptake (g ha^{-1})			
	PP	PD	Harvest		PP	PD	Harvest		PP	PD	Harvest	
			Haulm	Kernel			Haulm	Kernel			Haulm	Kernel
T_1: Control	15.44	18.67	11.09	8.48	60.7	68.3	40.8	24.4	34.5	54.1	30.6	21.6
T_2: 100% RDF	18.19	22.54	14.05	11.43	73.7	83.4	51.1	35.4	42.3	68.9	39.8	31.5
T_3: 125% RDF	21.18	26.58	16.69	13.81	87.0	97.6	61.3	43.0	51.0	83.5	49.1	39.1
T_4: 100% RDF + Soil application of $ZnSO_4$ @ 50kg ha^{-1} and Borax @ 10 kg ha^{-1}	24.30	31.49	20.76	16.29	103.5	117.9	76.8	49.9	81.4	126.8	78.9	57.8
T_5: 125% RDF + Soil application of $ZnSO_4$ @ 50 kg ha^{-1} and Borax @ 10 kg ha^{-1}	27.00	36.27	24.00	19.19	116.0	135.9	88.3	57.3	90.9	142.4	94.2	70.3
T_6: 100% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS	18.33	31.04	20.96	16.72	74.2	116.7	76.2	50.1	43.2	126.4	80.6	58.7
T_7: 125% RDF + Foliar application of $ZnSO_4$ @ 2 g L^{-1}, $FeSO_4$ @ 5 g L^{-1} and Borax @ 1.5 g L^{-1} at 45 and 65 DAS	21.35	35.89	24.48	19.34	87.2	134.0	91.2	57.8	51.3	141.4	95.9	70.6
SEm (±)	0.85	1.11	0.81	0.77	3.87	4.51	3.27	1.91	2.29	4.70	2.62	2.33
CD (p=0.05)	2.63	3.41	2.50	2.36	11.94	13.88	10.08	5.89	7.06	14.50	8.07	7.17
CV (%)	7.08	6.62	7.44	8.84	7.80	7.25	8.17	7.29	7.04	7.67	6.77	8.08

Table 3. Effect of macro and micronutrients on Cu, Mn and B uptake by groundnut

(PP-Peg Penetration Stage, PD-Pod development Stage)

Conclusion

From the analysis of experimental data, it could be concluded that the foliar application of zinc, iron and boron along with 125% RDF improved the uptake of all the nutrients in coastal sandy soils.

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