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Effect of Organic and Inorganic Sources of Nutrients on the Micronutrients Availability and Uptake by Groundnut in Loamy Sand Soil

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A B S T R A C T

A field experiment was conducted in a farmer's field during 2019-2021 to assess the response of organic and inorganic sources of nutrients in micronutrients uptake on groundnut in loamy sand soil of Chinnathanakuppan village, Cuddalore district, Tamil Nadu. The experimental soil having loamy sand in texture (*Typhic Rhodustalf*) had the value of pH 7.8 and EC of 0.41dSm^{-1}. The soil was low in organic carbon, alkaline $KMnO_4$–N, and Olsen-P and medium in NH_4OAC-K. Field experiment was conducted with the following treatments T_1 - RDF, T_2 - RDF + $ZnSO_4$, T_3 - RDF + Boron, T_4 - RDF + $ZnSO_4$ + Boron, T_5 - RDF + FYM, T_6 - RDF + $ZnSO_4$ + FYM, T_7 - RDF + Boron + FYM, T_8 - RDF + $ZnSO_4$ + Boron + FYM, T_9 - 75% RDF + HA, T_{10} - 75% RDF + $ZnSO_4$ + HA, T_{11} - 75% RDF + Boron + HA, T_{12} - 75% RDF + $ZnSO_4$ + Boron + HA, T_{13} - 50% RDF + LFA, T_{14} - 50% RDF + $ZnSO_4$ + LFA, T_{15} - 50% RDF + Boron + LFA, T_{16} - 50% RDF + $ZnSO_4$ + Boron + LFA. The experiment was laid out in randomized block design with three replications. Maximum uptake of micronutrients such as zinc, manganese, copper and boron as compared to 100% RDF alone at all stages of crop growth. Application of 100% RDF + FYM (T_5) @ 12.5 t ha^{-1} recorded the highest DTPA-extractable Cu and Mn. The highest DTPA extractable zinc was noticed in treatment 100% RDF + $ZnSO_4$ + FYM (T_6) but the highest boron was observed in treatment 100% RDF + Boron + FYM (T_7) in loamy sand soil. The results of the field experiment indicated that application of FYM @ 12.5 t ha^{-1} along with 75% RDF, $ZnSO_4$ @ 25 kg ha^{-1} + B @ 10 kg ha^{-1} + HA @ 20 kg ha^{-1} maximized the micronutrients uptake of groundnut in loamy sand soil of Cuddalore district as well as improved the availability of macro and micronutrients status of soil.

***Key words*:** Micronutrients, Mn, Zn, Cu and B, Groundnut, Loamy sand soil

Groundnut (*Arachis hypogaea* L.) is an important oil seed crop and it has been rightly acclaimed as "King of Oil Seeds" by virtue of its special attention as source of the most important edible oil used in grown is an area of 55.27 lakh ha with production of 96.72 lakh tonnes and productivity of 1.76 t ha^{-1} (2015-2016) in India. Tamil Nadu ranks third in the country with and area of 3.42 lakh ha contributing of 6.48 % and production of 9.62 lakh tonnes sharing 14.12 % with an average productivity of 2.81 t ha^{-1}. Among the districts of Tamil Nadu, Cuddalore district has a wider area of 1.57 lakh hectares under groundnut crop with the annual production of 2.42 lakh tonnes. Further, India's per capita consumption of oil and fat is continuously increasing, so there is an urgent need to increase groundnut production. India needs 34.63 mt of oil seeds to feed 1.3 billion population by 2020 [1] and groundnut is the most important food legume in terms of consumption and area under production. It contains 42 – 52 percentage oil and 22-30 percentage of protein on a dry seed basis and is rich source of minerals like phosphorus, calcium, magnesium and potassium [2] Besides being a source of income for farmers, groundnut provide an inexpensive source of high-quality dietary protein and oil in the diets [3]. Light textured soils have the problems beyond the capacity of the resource farmers to address. Exploitation of these stressed ecosystem for arable cropping increase with increasing population and the concomitant demand for food. From this perceptive, it is important that light textured soils handled as the next frontiers for agriculture [4]. The light texture soils are well known for the deficiency of micronutrients especially zinc and boron. In groundnut production and improving the quality, the zinc and boron plays a vital role. Absence of zinc in nutrient solutions resulted in reduction of flowers, pegs and reproductive branches and also decreased root and shoot growth [5]. Boron deficiency usually causes hollow heart. The deficiency has been reported in Punjab and Tamil

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Nadu. About 70% of Tamil Nadu soils and 20% of Madhya Pradesh soils are deficient in available boron [6].

Integrated application of organic and inorganic manures showed higher uptake of NPK rather than sole application of organic manures due to increased nutrient availability and improvement in physical condition of the soil. The available nutrient status of the soil significantly improved with combined application of organic and inorganic manures. Conjunctive use of organic manures and optimum dose of NPK produced the highest and sustainable crop yields and improved the fertility status of the soil [7]. The present investigation was, therefore undertaken to integrate the application of inorganic fertilizers along with organic sources and micronutrients so as to reduce or substitute the inorganic fertilizer requirement and to sustain the groundnut production in sandy loamy sand soil. The present investigation was, therefore undertaken to integrate the application of inorganic fertilizers along with organic sources and micronutrients so as to reduce or substitute the inorganic fertilizer requirement and to sustain the groundnut production in loamy sand soil.

MATERIALS AND METHODS

A field experiment was carried out in a farmer's field during December 2009 - March, 2010 at Chinnathanakuppan village, Cuddalore district, Tamil Nadu, to find out the influence of different organic and inorganic sources of nutrients on the micronutrient's availability and uptake by groundnut in a loamy sandy soil. The treatments consisted of different levels of NPK viz., 100% and 75% RDF and different sources of nutrients viz. FYM @ 12.5 t ha^{-1}, fly ash @ 10 t ha^{-1} and humic acid @ 20 kg ha^{-1} along with micronutrients boron @ 10 kg ha^{-1} and zinc sulphate @ 25 kg ha^{-1}. The soil of the experimental field was loamy sand in texture (*Typhic Haplustalf*) had the value of pH 6.8 and EC of 0.37 dSm^{-1}. The soil analyzed low in organic carbon, low in alkaline $KMnO_4$ -N, low in Bray-1- P and medium in NH_4OAC-K. Field experiment was conducted with the following treatments T_1 - RDF, T_2 - RDF + $ZnSO_4$, T_3 - RDF + Boron, T_4 -RDF + $ZnSO_4$ + Boron, T_5 - RDF + FYM, T_6 - RDF + $ZnSO_4$ + FYM, T_7 - RDF + Boron + FYM, T_8 - RDF + $ZnSO_4$ + Boron + FYM, T_9 - 75% RDF + HA, T_{10} - 75% RDF + $ZnSO_4$ + HA, T_{11} - 75% RDF + Boron + HA, T_{12} - 75% RDF + $ZnSO_4$ + Boron + HA, T_{13} - 50% RDF + LFA, T_{14} - 50% RDF + $ZnSO_4$ + LFA, T_{15} - 50% RDF + Boron + LFA,T_{16} - 50% RDF + $ZnSO_4$ + Boron + LFA. The data recorded on various parameters during the course of investigation and the summed-up data were statistically analyzed following the analysis of variance for randomized block design with three replications. The experiment was laid out in randomized block design with three replications and tested with groundnut crop Var. JL- 11. Required quantities of nutrient sources as per the treatment schedule were incorporated. Calculated amount of fertilizer doses of 17:34:54 kg N: P_2O_5:K_2O ha^{-1} was applied in loamy sand soil as per the treatment schedule. The total uptake of individual micronutrient was computed by multiplying the respective nutrient content with DMP. At harvest stage, the nutrient uptake by pod and haulm were also computed.

Table 1 Effect of organic and inorganic sources of nutrients on micronutrients (g ha^{-1}) uptake by groundnut

Treatments	Zinc				Copper				Manganese				Boron			
	FS	PFS	POD	HAULM	FS	PFS	POD	HAULM	FS	PFS	POD	HAULM	FS	PFS	POD	HAULM
T_1	127.52	266.20	123.61	91.99	87.50	81.29	85.80	33.63	124.50	127.00	120.30	87.90	1.280	1.730	1.803	3.540
T_2	138.80	290.02	134.54	100.12	91.89	86.45	89.14	35.03	129.87	133.34	127.44	92.25	1.344	1.890	1.965	3.856
T_3	133.95	279.19	129.85	96.64	95.20	89.60	93.44	36.30	134.45	139.52	132.10	95.60	1.395	1.820	1.895	3.720
T_4	146.92	306.90	142.30	105.95	100.97	94.78	98.45	38.43	142.32	146.20	139.80	101.19	1.475	1.999	2.075	4.081
T_5	151.71	317.00	147.02	109.90	103.88	97.94	102.08	39.80	146.99	151.10	144.40	104.50	1.524	2.064	2.146	4.210
T_6	158.12	330.45	153.30	113.10	105.76	98.18	103.62	40.24	148.50	152.70	145.90	105.60	1.537	2.160	2.240	4.393
T_7	153.24	320.15	148.60	110.65	108.02	102.05	107.40	41.40	153.42	157.45	150.45	108.95	1.589	2.085	2.170	4.266
T_8	161.37	337.25	156.45	116.44	110.76	104.18	108.62	42.24	156.37	160.76	153.62	111.20	1.620	2.196	2.284	4.485
T_9	100.02	209.05	96.99	72.16	67.90	63.45	67.30	26.21	96.94	100.02	95.26	68.94	1.002	1.363	1.415	2.788
T_{10}	107.42	222.55	103.20	76.86	69.70	65.60	68.30	26.60	98.40	101.25	96.78	70.02	1.020	1.450	1.506	2.962
T_{11}	101.52	212.40	98.56	73.58	73.08	68.70	71.70	27.86	104.45	106.08	101.30	73.40	1.069	1.380	1.438	2.824
T_{12}	113.59	236.07	109.50	81.50	78.22	72.80	76.02	29.55	109.40	113.50	107.50	79.48	1.134	1.537	1.599	3.140
T_{13}	78.45	148.26	68.80	51.22	48.35	44.80	47.80	18.60	68.75	68.37	66.49	48.90	0.710	0.970	1.003	1.970
T_{14}	80.05	165.24	76.66	57.02	53.10	50.00	52.10	20.17	75.01	77.10	73.20	52.37	0.798	1.074	1.119	2.196
T_{15}	79.54	161.85	75.02	55.90	54.20	51.02	53.20	20.72	76.69	78.70	75.25	54.50	0.795	1.052	1.095	2.156
T_{16}	82.90	175.30	81.34	60.22	57.50	56.30	57.84	21.99	81.30	84.60.	79.90	57.80	0.842	1.140	1.186	2.336
SED	3.75	8.26	3.65	2.83	2.64	2.58	2.63	1.03	3.76	3.94	3.68	2.67	0.039	0.054	0.056	0.107
CD (P=0.05)	7.66	16.86	7.43	5.77	5.40	5.28	5.37	2.11	7.67	8.03	7.52	5.44	0.079	0.109	0.114	0.218

RESULTS AND DISCUSSION

Uptake of micronutrients by groundnut

Uptake of micronutrients

Zinc and boron deficiency is most common in sandy clay loam and loamy sand soil. Absence of zinc in nutrient solution resulted in reduction of flowers, pegs and reproductive branches in groundnut. Boron deficiency usually causes hollow heart in groundnut. Boron exerts its significant role in pollen tube germination, fertilization, seed setting, yield and quality of groundnut. These two micronutrient elements were most deficient in sandy soils.

In sandy soil, even the application of micronutrients, due to leaching and poor ion exchange properties, the efficiency of applied nutrients are also reduced. Application of organic source of nutrients in such soil improves the efficiency of the applied nutrients, through chelation action and increased nutrient retention in soil. Hence, in the present investigation the influence of various treatments on the nutrition of micronutrients to groundnut assumes greater importance. In the present investigation, application of 75% RDF + $ZnSO_4$ + Boron + FYM significantly promoted the nutrition of Zn, B, Cu and Mn in groundnut. The increased uptake of these nutrients might be because of addition of these nutrients through fertilizers. The increased Mn uptake might be due to addition of micronutrients as impurities along with fertilizers. Further, the application of organics might have increased the availability through enhanced mineralization and chelation action which have increased the absorption and utilization of these nutrients [8-11]. The uptake of Zn, Cu, Mn and B was favourably influenced with the application of 75% RDF + $ZnSO_4$ + Boron + FYM. This could be attributed to increased availability of macronutrients through applied fertilizer and due to beneficial effect of organics which resulted in higher absorption of nutrients and promoted crop biomass production [12]. The total uptake of Zn, Cu, Mn and Fe increased significantly with the conjoint application of organics and recommended fertilizers in comparison with control. The lowest Zn, Cu, Mn and Fe uptake by rice was recorded in control and recommended fertilizers alone treatments followed by organics treatments [13].

Table 2 Effect of organic and inorganic sources of nutrients on available micronutrients (mg kg^{-1}) in loamy sand soil

Treatments	Copper			Zinc			Manganese			Boron		
	FS	PFS	POD	FS	PFS	POD	FS	PFS	POD	FS	PFS	POD
T_1	0.585	0.401	0.386	1.37	1.17	0.92	14.83	13.33	11.89	0.065	0.061	0.059
T_2	0.578	0.391	0.383	1.47	1.26	0.99	14.05	13.31	11.75	0.064	0.060	0.058
T_3	0.561	0.383	0.377	1.32	1.16	0.90	13.93	13.30	11.32	0.069	0.064	0.062
T_4	0.541	0.378	0.369	1.42	1.21	0.96	13.58	13.30	11.20	0.068	0.063	0.060
T_5	0.645	0.454	0.412	1.57	1.35	1.06	16.40	14.50	13.69	0.070	0.064	0.060
T_6	0.620	0.445	0.408	1.67	1.42	1.12	16.20	14.45	13.45	0.068	0.061	0.059
T_7	0.610	0.428	0.397	1.52	1.30	1.02	15.65	14.01	13.09	0.073	0.067	0.065
T_8	0.601	0.412	0.393	1.63	1.39	1.09	15.08	13.91	12.10	0.071	0.065	0.064
T_9	0.516	0.356	0.319	1.28	1.11	0.80	13.51	12.60	11.06	0.062	0.057	0.056
T_{10}	0.509	0.345	0.310	1.40	1.22	0.86	13.40	12.56	10.91	0.060	0.056	0.054
T_{11}	0.492	0.337	0.302	1.25	1.04	0.78	13.16	12.02	10.45	0.065	0.061	0.060
T_{12}	0.478	0.330	0.298	1.32	1.15	0.83	12.63	11.90	10.40	0.063	0.059	0.058
T_{13}	0.466	0.323	0.287	1.09	1.02	0.71	12.21	11.20	10.12	0.057	0.053	0.048
T_{14}	0.452	0.317	0.280	1.24	1.13	0.76	12.11	11.04	9.97	0.056	0.052	0.047
T_{15}	0.441	0.305	0.274	1.02	0.97	0.66	11.63	10.66	9.62	0.060	0.055	0.052
T_{16}	0.429	0.296	0.272	1.19	1.09	0.74	11.35	10.48	9.43	0.059	0.055	0.050
SED	0.015	0.011	0.005	0.041	0.035	0.027	0.377	0.347	0.278	0.0016	0.0015	0.0012

Available micronutrients

Soil available Zn, B, Cu and Mn status were significantly influenced by 75% RDF, Zn, B, FYM and their application. The available Zn, B, Cu and Mn were low in combined application of 75% RDF + $ZnSO_4$ + Boron + FYM added treatments. Application of 75% RDF, $ZnSO_4$, Boron and FYM increased the growth, yield attributes, pod and haulm yield and uptake of nutrients in the present investigation. This probably resulted in low available nutrients due to removable from the soil pool. The decrease in available micronutrients with combined application of 75% RDF, $ZnSO_4$, Boron and FYM application was quite natural, because they have increased the uptake of all nutrients which was drawn from soil, result depletion according to growth, development and yield of crops.

A significant buildup of available Zn due to zinc sulphate application had been reported by [14]. Further, the inclusion of FYM also contributed significantly to the buildup of Zn content in soil over 100% NPK treatment. This could be attributed to the direct contribution of FYM to nutrient pool and its beneficial effects either through complexation and mobilization of native Zn [15-16].

CONCLUSION

The highest pod and haulm yield as well as uptake of Cu, Zn, Mn and B were noticed in 75% RDF + FYM @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + Boron @ 10 kg ha^{-1} + HA @ 20 kg ha^{-1} (T_8). The highest available Cu and Mn were noticed in RDF + FYM (T_5) and highest DTPA extractable Zn was observed in RDF + $ZnSO_4$ + FYM (T_6) and Maximum available boron noticed in RDF + Boron + FYM (T_7) combination treatment. The results of the field experiments indicated that application of FYM @ 12.5 t ha^{-1} along with 75% RDF, $ZnSO_4$ @ 25 kg ha^{-1} + B @ 10 kg ha^{-1} + HA @ 20 kg ha^{-1} maximized the yield of groundnut in

loamy sand soils of Cuddalore district as well as improved the availability of macro and micronutrients status of soil.

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