International Journal of Advanced Research in Biological Sciences
ISSN : 2348-8069
www.ijarbs.com

Research Article

Effect of organic and inorganic sources of nutrients on availability of NPK and Boron, Zinc at different growth stages of groundnut in two texturally different soils.

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Abstract

Field experiments were carried out in a farmers field at Chinnathanakuppam and Ayeekuppam villages, Cuddalore district during December 2009 and March, 2009. The experimental site at Chinnathanakuppam belongs to Vadalapakkam series (*Typic Rhodustalf*) with sandy clay loam texture having pH 7.8 and EC 0.36 dSm^{-1}. The soil was low in organic carbon 3.4 g kg^{-1}, medium is in alkaline $KMnO_4$-N 285 kg ha^{-1}, low in olsen-P 11 kg ha^{-1} and medium NH_4OAC-K 190 kg ha^{-1} The experimental soil at Ayeekuppam belongs to Vadupudupet series (*TypicHaplustalf*) with loamy sand in texture, having pH 8.1 and EC 0.41 dSm^{-1}, the soil was low in OC (2.8 g ha^{-1}), low in available nitrogen (230 kg ha^{-1}) and P (9.0 kg ha^{-1}) and medium in available K (160 kg ha^{-1}). The experiment was conducted with 16 treatment combinations. The treatment consisted of different levels of NPK *viz.*, 100%, 75% and 50% RDF and different sources of nutrients *viz.*, farmyard manure @ 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 experiment was laid out in randomized block design (RBD) with three replications and tested with groundnut crop JL-11. The results reveled that the combined application of 100% RDF + FYM significantly increased availability of Nitrogen, Phosphorus and Potassium at all stages of crop growth in both soils. Among the micronutrients, 100% RDF+$ZnSO_4$+FYM recorded maximum *DTPA* extractable zinc and 100% RDF+Boron+FYM treatment registered maximum Hot water soluble boron in both sandy clay loam and loamy sand soils flowering, peg formation and harvest stage respectively.

Keywords: Major and micronutrients availability, texturally different soils, different growth stages, ground nut crop.

Introduction

Oilseeds crops are considered as the backbone of agricultural economy in India. Among the oilseed crops grown in India, groundnut contributes 25.13% of the total area and 19% of the total production. Groundnut crop ranks first in area and second in production in the world (DOES, 2012). In sandy clay loam and loamy sand soils due to low organic matter, poor nutrient status and loss of applied nutrients through leaching, there is a need to test the response of groundnut to different levels of RDF, micronutrients with various organic sources of nutrients in these soils. Integrated use of organic and inorganic sources of nutrients is best option for maintaining soil fertility and to achieve higher groundnut production was reported by many authors (Nagarajah *et al.*, 1986; Singh *et al.*, 1990). This experiment was therefore carried out to study the effect of integration of organic and inorganic sources of nutrients on major and micronutrient status in two texturally different soils.

Materials and Methods

Field experiments were conducted in sandy clay loam and loamy sand texture soils of Cuddalore district, Tamil Nadu to find out the effect of organic and inorganic sources of nutrients with varying levels of

RDF on the major and micronutrient availability in groundnut cropped field. The experimental soil at Chinnathanakuppam village belongs to Vadalapakkam series (*Typic Rrhodustalf*) with sandy clay loam texture having pH – 7.8 and EC – 0.36 dSm^{-1}. The soil was low in organic carbon 3.4 g kg^{-1}, medium is in alkaline $KMnO_4$-N 285 kg ha^{-1}, low in olsen-P 11 kg ha^{-1} and medium NH_4OAC-K 190 kg ha^{-1}.The experimental soil at Ayeekuppam village belongs to Vadapudupet series (*Typic Haplustalf*) with loamy sand in texture, having a pH 8.1 and EC 0.41 dSm^{-1}.The soil was low in OC (2.8 g kg^{-1}), low in available N (230 kg ha^{-1}) and P (9.0 kg ha^{-1}) and medium in available K (160 kg ha^{-1}).The experiment was conducted with 16 treatments combinations. The treatments consisted of different levels of NPK *viz.,* 100%, 75% and 50% RDF and different sources of nutrients *viz.*, farmyard manure @ 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 experiments was laid out in randomized block design (RBD) with three replications and tested with groundnut crop variety JL-11. Soil samples at flowering, peg formation and harvest stages were collected and analyzed for available NPK and micronutrients as per the standard procedure (Jackson, 1973).

Results and Discussion

Available major nutrients

Alkaline $KMnO_4$-N

The available nitrogen status in soil was significantly influenced due to application of organic and inorganic sources of nutrients. Application of 100% RDF + FYM @ 12.5 t ha^{-1} (T_5) (Table 1) recorded the highest $KMnO_4$- N 213.0, 192 and 184.3 kg ha^{-1} in sandy clay loam soil and 171.8, 159.2 and 155.1 kg ha^{-1} in loamy sand soil at flowering, peg formation and harvest stages respectively. Regarding 50% RDF treatment combinations, 50% RDF+FA (T_{13}) showed maximum available nitrogen of 160.5,159.2 and 140.5 kg ha^{-1} in sandy clay loam soil and 116.8,115.3 and 108.9 kg ha^{-1} in loamy sand soil at flowering, peg formation and harvest stages respectively. The lowest soil available nitrogen recorded is the treatment T_{16} (50% RDF+$ZnSO_4$+Boron+FA) with a value of 145.8,148.6 and 129.15 kg ha^{-1} in sandy clay loam soil and 108.7,105.1 and 101.3 kg ha^{-1} at flowering, peg formation and harvest stages in loamy sand soil respectively.

Table1. Effect of organic and inorganic sources of nutrients on available nitrogen (kg ha^{-1}) in soil

Treatments	Sandy clay loam soil			Loamy sand soil		
	FS	PFS	HS	FS	PFS	HS
T_1- RDF	198.4	172.7	166.3	152.6	143.6	139.5
T_2- RDF+ $ZnSO_4$	193.4	165.6	160.2	149.7	140.9	136.7
T_3- RDF + Boron	195.2	168.3	164.2	147.3	141.2	134.7
T_4- RDF+ $ZnSO_4$+ Boron	185.6	162.7	158.3	143.5	134.4	132.1
T_5 – RDF + FYM	213.0	192.0	184.3	171.8	159.2	155.1
T_6 –RDF+ $ZnSO_4$ + FYM	206.5	188.3	179.2	167.5	156.3	153.6
T_7 –RDF + Boron + FYM	210.2	190.5	181.2	165.2	154.2	150.3
T_8 - RDF+ $ZnSO_4$+ Boron + FYM	201.1	181.1	176.6	162.3	150.7	147.2
T_9 – 75% RDF + HA.	175.1	153.2	150.3	131.2	126.4	124.2
T_{10} –75% RDF + $ZnSO_4$+ HA.	166.5	145.7	146.2	125.5	121.2	114.2
T_{11} -75% RDF + Boron+ HA.	168.2	147.2	148.5	123.4	118.4	112.6
T_{12} –75% RDF + $ZnSO_4$+ Boron+ HA.	163.6	162.0	142.3	120.3	118.2	111.8
T_{13} – 50% RDF + LFA	160.5	159.2	140.5	116.8	115.3	108.9
T_{14} –50% RDF + $ZnSO_4$ + LFA	156.2	154.4	135.4	114.2	114.0	106.5
T_{15} -50% RDF + Boron + LFA	157.1	157.9	138.6	113.6	112.2	104.2
T_{16}-50% RDF + $ZnSO_4$ +Boron +LFA	145.8	148.6	129.1	108.7	105.1	101.3
SED	5.19	4.22	3.53	4.19	3.41	3.06
CD (P=0.05)	10.6	8.62	7.22	8.55	6.96	6.25

The increase in available N status due to organic manure application might be due to multiplication of soil microbes leading to enhanced conversion of organically bound N into inorganic forms, rapid mineralization and thus made available to the crops (Miller *et al.,* 1987); Katkar *et al.* (2012) have also reported higher buildup of soil available N under integrated nutrient supply system.

Olsen-P

100% NPK treatment combinations significantly influenced Olsen-P status at flowering, peg formation and harvest stages in both soils (Table 2). Among 100% RDF treatments, treatment T_5 (100% RDF + FYM @ 12.5 t ha^{-1}) showed maximum of 21.2, 20.3 and 18.9 kg ha^{-1} in sandy clay loam soil and 13.0, 12.7 and 12.3 kg ha^{-1} in loamy sand soil at flowering, peg formation and harvest stages respectively. Among the 50% RDF levels, 50% RDF+$ZnSO_4$+Boron+FA (T_{16}) showed lowest phosphorus values of 11.5,11.1 and 10.3 kg ha^{-1} in sandy clay loam soil and 9.0,8.8 and 8.5 in loamy sand soil at flowering, peg formation and harvest stages respectively. Decomposition of organic manure produces various organic acids which solubilize phosphate and other phosphate bearing minerals and thereby increase P availability in soil (Tolanur and Badanur, 2003). The findings also corroborates with the results reported by Verma *et al.* (2005).

Table 2. Effect of organic and inorganic sources of nutrients available the phosphorus (kg ha^{-1}) in soil

Treatments	Sandy clay loam soil			Loamy sand soil		
	FS	PFS	HS	FS	PFS	HS
T_1- RDF	17.2	16.1	16.0	14.6	13.8	13.7
T_2- RDF+ $ZnSO_4$	16.5	15.9	15.7	13.4	13.5	13.0
T_3- RDF + Boron	16.9	16.0	15.8	13.1	13.1	12.8
T_4- RDF+ $ZnSO_4$+ Boron	16.0	14.4	15.0	13.0	12.7	12.3
T_5 – RDF + FYM	21.2	20.3	18.9	18.4	18.2	16.9
T_6 –RDF+ $ZnSO_4$ + FYM	20.3	19.5	18.3	18.2	17.9	16.6
T_7 –RDF + Boron + FYM	21.9	19.8	18.6	17.9	16.8	16.4
T_8 - RDF+ $ZnSO_4$+ Boron + FYM	20.2	19.4	18.2	17.4	16.3	15.5
T_9 – 75% RDF + HA.	15.1	14.7	14.0	12.2	11.9	10.9
T_{10} -75% RDF + $ZnSO_4$+ HA.	14.2	13.1	12.4	12.0	11.5	10.7
T_{11} -75% RDF + Boron+ HA.	14.7	13.8	12.8	11.7	10.8	10.4
T_{12} –75% RDF + $ZnSO_4$+ Boron+ HA.	13.9	13.3	12.1	11.5	10.5	10.1
T_{13} – 50% RDF + LFA	12.7	12.3	11.2	10.2	9.9	9.5
T_{14} –50% RDF + $ZnSO_4$ + LFA	12.1	11.7	10.6	9.9	9.5	9.3
T_{15} -50% RDF + Boron + LFA	12.5	12.1	11.0	9.2	9.0	8.6
T_{16} -50% RDF + $ZnSO_4$ +Boron +LFA	11.5	11.1	10.3	9.0	8.8	8.5
SED	0.524	0.50	0.36	0.44	0.44	0.31
CD (P=0.05)	1.07	1.02	0.73	0.91	0.90	0.63

NH_4OAC-K

100% RDF treatment combinations significantly influenced soil potassium at all stages of crop growth (Table 3).Application of 100% RDF + FYM @ 12.5 t ha^{-1} (T_5) recorded maximum NH_4OAC-K of 275.8, 261.1 and 246.6 in sandy clay loam soil and 240.5, 230.0 and 216.9 kg ha^{-1} in loamy sand soil at flowering, peg formation and harvest stages respectively. Addition of FA with 50% RDF caused significant soil available potassium values at all stages of crop growth. Application 50% RDF+$ZnSO_4$+Boron+FA (T_{16}) registered lowest available soil potassium of 205.3, 185.6 and 183.0 kg ha^{-1} in sandy clay loam soil and 175.2,163.7 and 157.1 kg ha^{-1} in loamy sand soil at flowering, peg formation and harvest stages respectively. Increase in available K might be due to direct addition to the available K pool of the soil, besides reduced K fixation and release of K due to the interaction

Table 3. Effect of organic and inorganic sources of nutrients on available potassium (kg ha^{-1}) in soil

Treatments	Sandy clay loam soil			Loamy sand soil		
	FS	PFS	HS	FS	PFS	HS
T_1- RDF	258.0	243.3	230.4	225.5	214.6	201.6
T_2- RDF+ $ZnSO_4$	249.4	235.4	221.3	222.3	212.5	198.5
T_3- RDF + Boron	254.7	240.9	227.9	218.5	208.5	191.3
T_4- RDF+ $ZnSO_4$+ Boron	243.7	229.4	216.1	209.1	198.9	187.1
T_5 – RDF + FYM	275.8	261.2	246.6	240.5	230.0	217.0
T_6 –RDF+ $ZnSO_4$ + FYM	265.1	255.4	241.6	236.7	227.3	214.7
T_7 –RDF + Boron + FYM	270.6	258.3	244.3	232.1	224.5	211.0
T_8 - RDF+ $ZnSO_4$+ Boron + FYM	241.7	247.2	233.4	228.4	217.5	204.1
T_9 – 75% RDF + HA.	240.0	225.4	213.3	207.5	195.7	185.7
T_{10} –75% RDF + $ZnSO_4$+ HA.	232.5	219.7	208.2	204.9	192.9	181.9
T_{11} -75% RDF + Boron+ HA.	238.2	222.4	210.9	200.7	189.4	178.5
T_{12} –75% RDF + $ZnSO_4$+ Boron+ HA.	227.7	213.7	201.6	195.0	184.9	174.1
T_{13} – 50% RDF + LFA	219.2	197.8	196.2	188.5	179.5	170.0
T_{14} –50% RDF + $ZnSO_4$ + LFA	211.9	189.4	188.5	184.7	175.5	165.4
T_{15} -50% RDF + Boron + LFA	216.6	193.4	191.2	179.7	169.4	160.4
T_{16} -50% RDF + $ZnSO_4$ +Boron +LFA	205.3	185.6	182.6	175.3	163.7	157.1
SED	6.26	5.91	5.55	5.40	5.14	4.82
CD (P=0.05)	12.78	12.05	11.34	11.02	10.50	9.84

of organic matter with clay. The increased availability of K with FYM application might be due to the solubilization action of certain organic acids produced during decomposition of organic manures and its greater capacity to hold K in availability from in soil and also due to interaction of organic matter with clay and direct addition of K to the available pool of soil. Similar beneficial effect of organic manures in increasing soil K were reported by Pawar *et al.*, 1997 and Sharma *et al.*, 2001.

Available micronutrients

DTPA extractable zinc

Addition of organic, inorganic and micronutrients and their combination resulted in significant variations on available at all stages of crop growth (Table 4).

Table 4. Effect of organic and inorganic sources of nutrients on available zinc (mg kg^{-1}) in soil

Treatments	Sandy clay loam soil			Loamy sand soil		
	FS	PFS	HS	FS	PFS	HS
T_1- RDF	1.75	1.42	1.18	1.37	1.17	0.92
T_2- RDF+ $ZnSO_4$	1.86	1.57	1.24	1.47	1.26	0.99
T_3- RDF + Boron	1.70	1.45	1.15	1.32	1.16	0.90
T_4- RDF+ $ZnSO_4$+ Boron	1.82	1.40	1.20	1.42	1.21	0.96
T_5 – RDF + FYM	1.96	1.68	1.32	1.57	1.35	1.06
T_6 –RDF+ $ZnSO_4$ + FYM	2.07	1.76	1.38	1.67	1.42	1.12
T_7 –RDF + Boron + FYM	1.90	1.61	1.27	1.52	1.30	1.02
T_8 - RDF+ $ZnSO_4$+ Boron + FYM	2.06	1.74	1.35	1.63	1.39	1.09
T_9 – 75% RDF + HA.	1.52	1.45	1.07	1.28	1.11	0.80
T_{10} -75% RDF + $ZnSO_4$+ HA.	1.63	1.54	1.13	1.40	1.22	0.86
T_{11} -75% RDF + Boron+ HA.	1.46	1.41	1.02	1.25	1.04	0.78
T_{12} –75% RDF + $ZnSO_4$+ Boron+ HA.	1.60	1.50	1.10	1.32	1.15	0.83

T_{13} – 50% RDF + LFA	1.45	1.35	0.97	1.09	1.02	0.71
T_{14} –50% RDF + $ZnSO_4$ + LFA	1.55	1.46	1.04	1.24	1.13	0.76
T_{15} -50% RDF + Boron + LFA	1.40	1.30	0.92	1.02	0.97	0.66
T_{16}-750% RDF + $ZnSO_4$ +Boron +LFA	1.52	1.42	1.01	1.19	1.09	0.74
SED	0.050	0.043	0.034	0.041	0.035	0.027
CD (P=0.05)	0.104	0.088	0.069	0.084	0.071	0.056

Among the 100% RDF treatments, 100% RDF+$ZnSO_4$+FYM (T_6) recorded maximum available Zn of 2.07, 1.76 and 1.38 mg kg^{-1} in sandy clay loam and 1.67, 1.42 and 1.12 mg kg^{-1} in loamy sand soil at flowering, peg formation and harvest stage respectively. Treatment T_{15} (50% RDF+Boron+FA) registered lowest soil available zinc of 1.55, 1.46 and 1.04 mg kg^{-1} in sandy clay loam soil and 1.40.1.22 and 0.86 mg kg^{-1} in loamy sand soil at flowering, peg formation and harvest stage respectively. The increased availability with the addition of $ZnSO_4$ along with 100% RDF +FYM in complexing and mobilizing property might have increased the DTPA-Zn in soil. Earlier report of Thampan (1993) supports the present findings. Build up in available Zn due to organic matter application has been reported several workers (Sakal *et al.* 1996; Singh *et al.*1998) .The build up of Zn occurs through organic matter addition, $ZnSO_4$ application or exploitation of native Zn by chelation through decomposition product of organic matter. Organic matter has also reported to increase the efficiency of applied Zn as an inorganic fertilizer (Singh *et al*. 1998).

Hot water soluble boron

Integrated application of RDF, FYM, HA, FA and micronutrients and their combinations significantly influenced the availability of boron in soil (Table 5).

Table 5. Effect of organic and inorganic sources of nutrients on available boron (mg kg^{-1}) in soil

Treatments	Sandy clay loam soil			Loamy sand soil		
	FS	PFS	HS	FS	PFS	HS
T_1- RDF	0.075	0.074	0.070	0.065	0.061	0.059
T_2- RDF+ $ZnSO_4$	0.073	0.073	0.069	0.064	0.060	0.058
T_3- RDF + Boron	0.079	0.075	0.073	0.069	0.064	0.062
T_4- RDF+ $ZnSO_4$+ Boron	0.078	0.075	0.072	0.068	0.063	0.060
T_5 – RDF + FYM	0.086	0.074	0.073	0.070	0.064	0.060
T_6 –RDF+ $ZnSO_4$ + FYM	0.083	0.073	0.072	0.068	0.061	0.059
T_7 –RDF + Boron + FYM	0.090	0.077	0.076	0.073	0.067	0.065
T_8 - RDF+ $ZnSO_4$+ Boron + FYM	0.087	0.076	0.074	0.071	0.065	0.064
T_9 – 75% RDF + HA.	0.068	0.070	0.066	0.062	0.057	0.056
T_{10} -75% RDF + $ZnSO_4$+ HA.	0.065	0.068	0.065	0.060	0.056	0.054
T_{11} -75% RDF + Boron+ HA.	0.073	0.072	0.071	0.065	0.061	0.060
T_{12} –75% RDF + $ZnSO_4$+ Boron+ HA.	0.070	0.071	0.067	0.063	0.059	0.058
T_{13} – 50% RDF + LFA	0.063	0.064	0.062	0.057	0.053	0.048
T_{14} –50% RDF + $ZnSO_4$ + LFA	0.062	0.063	0.061	0.056	0.052	0.047
T_{15} -50% RDF + Boron + LFA	0.067	0.067	0.064	0.060	0.055	0.052
T_{16} -50% RDF + $ZnSO_4$ +Boron +LFA	0.064	0.066	0.063	0.059	0.055	0.050
SED	0.0019	0.0018	0.0015	0.0016	0.0015	0.0012
CD (P=0.05)	0.0038	0.0037	0.0030	0.0032	0.0030	0.0024

Application of 100% +Boron+FYM (T_7) showed highest soil boron values of 0.090 and 0.073 mg kg^{-1} at flowering, 0.077 and 0.067 mg kg^{-1} at peg formation, 0.076 and 0.065 mg kg^{-1} at harvest in sandy clay loam and loamy sand soils and minimum soil available boron values noticed in T_{14} treatment (50%RDF+$ZnSO_4$+FA).The availability of micronutrients, Zn and boron in soil was significantly increased with the application of borax along with FYM. Among the different treatments, the application of 100% RDF+boron was associated with the increased availability of the above nutrients. These findings are in line with earlier report of Reavathy *et al.* (1997) and Tripathy *et al.* (1999). Further the stimulatory effects of boron on these nutrients also explain the reason for the higher availability. Similar findings were already reported by Tandon (1992) and Shankhe *et al.* (2004). The increased status of available B with addition of boron fertilizer may be due to the increased availability of B in the soil. The formation of chelates with organic ligands due to addition of FYM might have lowered susceptibility of B to adsorption, fixation and precipitation resulting higher B availability in soil. Similar findings on increase in soil B due to fertilizer and manure application have also been reported by Varghese and Duraisami (2005) and Negassa *et al.* (2005).

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