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Influence of Organic Manures Integrated with Inorganic Fertilizer on Soil Properties After Harvest of Crops in Maize-Groundnut Crop Sequence

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Abstract Direct and residual effect of integrated nutrient management in Maize-Groundnut crop sequence in Southern Telangana region was conducted during *kharif* and *rabi* 2014-15 and 2015-16. The experiment was laid out in a randomized block design for maize during *kharif* 2014 and 2015 with six treatments consisting of combinations of three fertilizer levels 100,75 and 50% RDF through fertilizer and 25 and 50% RDN through two manures (FYM, Urban compost) with four replications. In succeeding *rabi* season, the experiment was laid out in split-plot design by taking five residual treatments from preceding maize as main plots and each at 50, 75 and 100% RDF as three sub-treatments with 3 replications. Post harvest available (N, P and K) content after *kharif* maize were significantly higher with interaction of residual 50% RDF + 50% RDN through urban compost (M_5) and 100% RDF (S_1) on par with interaction of residual 50% RDF + 50% RDN through FYM (M_3) and 100% RDF (S_1). Physicochemical properties viz. pH, EC, OC of soil were not significantly influenced by different treatments during both the years.

Keywords Urban compost, FYM, pH, EC, OC.

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Introduction

Maize (*Zea mays* L.) is one of the most important cereal crops of the world, occupying third rank in production after wheat and rice. In India, maize ranks third in terms of area sown and production next to rice and wheat. India produced 14.7 million tonnes of maize from 7.4 million hectares of land with an average productivity of maize in India and Telangana is 1.72 and 1.26 t ha^{-1}, respectively as compared to highest yield realized in USA (8.4 t ha^{-1}). Maize has wide distribution and varied uses as food, feed and fodder.

Table 1. Available N (kg ha^{-1}) in post harvest soil of *rabi* groundnut after *kharif* maize as influenced by different treatments.

Treatments given to *kharif* maize (M)	Treatments given to *rabi* groundnut (S) 2014-15 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean	2015-16 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean
M_1 - 100% RDF of NPK	157.8	151.3	143.6	150.9	173.6	166.4	158.0	166.0
M_2 - 75% RDF of NPK + 25% N-FYM	163.9	157.9	147.8	156.5	180.3	173.7	162.6	172.2
M_3 - 50% RDF of NPK + 50% N-FYM	172.3	166.4	158.9	165.9	189.5	183.0	174.8	182.5
M_4 - 75% RDF of NPK + 25% N-Urban Compost	165.3	160.4	151.6	159.1	181.8	176.4	166.8	175.0
M_5 - 50% RDF of NPK + 50% N-Urban Compost	176.4	170.7	163.9	170.3	194.0	187.8	180.3	187.4
Mean	167.1	161.3	153.2		183.9	177.5	168.5	
	SEm±	CD (p=0.05)				SEm±	CD (p=0.05)	
M	2.87	5.47			M	3.04	6.39	
S	3.40	6.89			S	3.10	7.21	
M at S	2.20	NS			M at S	3.73	NS	
S at M	2.89	NS			S at M	2.93	NS	

Maize is an exhaustive crop and requires very high doses of nitrogen and other nutrients. Ensuring balanced quantity of nutrients in a given soil for good plant growth is the greatest challenge of the dry as yield potentials vary among soils. For maintaining sustained crop production, balanced manuring is essential to build up soil health. Wide use of short statured high yielding varieties and hybrids is common in maize. The organic sources will improve the nutrient use efficiency of added chemical fertilizers by reducing nutrient losses and enhancing nutrient availability to plant. Integration and incorporation of organic manure (FYM/urban compost) in the agricultural systems helps to improve soil structure, soil microbial activity and soil moisture conservation and which in turn helps to stabilize the production and productivity of the crops. INM is also important for marginal farmers who cannot afford to supply crop nutrients through costly chemical fertilizers.

Groundnut, the premier oilseed crop of India, occupies in an area of about 6.7 million ha and contributes 7.3 million tonnes towards the oilseed production. India stands first in area and second in production, and fifth in productivity (1,000 kg ha^{-1}) after USA, China, Indonesia and Nigeria. The productivity of groundnut is low in India when compared with other countries mainly due to rain dependency (85%), monoculture (60%) and cultivation on marginal soils of low fertility. Groundnut is an energy rich crop and needs sufficient amount of nutrients and moisture to meet their requirement for growth and development and high yields. Sustainable groundnut production can be achieved by diversifying the groundnut cropping system and nutrient management practices [1].

Maize (*Zea mays* L.) – groundnut (*Arachis hypogaea*) is one of the important cropping systems in Andhra Pradesh of India and maintenance of optimum soil fertility is an important consideration for obtaining higher and sustainable yield. The responses of the succeeding crops in a cropping system are influenced greatly by the preceding crops and the inputs applied therein. Therefore, recently greater emphasis is being laid on the cropping system as whole rather than on the individual crops in a sequence.

Materials and Methods

A field experiment on Direct and residual effect of integrated nutrient management in maize-groundnut crop sequence in Southern Telangana region was conducted during *kharif* and *rabi* 2014-15 and 2015-16 at College Farm, College of Agriculture, Rajendranagar, Hyderabad, Southern Telangana climatic Zone of Telangana. The soil of experimental

Table 2. Available P_2O_5 (kg ha^{-1}) in post harvest soil of *rabi* groundnut after *kharif* maize as influenced by different treatments.

Treatments given to *kharif* maize (M)	Treatments given to *rabi* groundnut (S) 2014-15 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean	2015-16 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean
M_1 - 100% RDF of NPK	67.5	64.2	58.7	63.5	74.3	70.6	64.6	69.81
M_2 - 75% RDF of NPK + 25% N-FYM	68.7	65.9	60.2	64.9	75.6	72.5	66.2	71.43
M_3 - 50% RDF of NPK + 50% N-FYM	69.6	67.7	64.3	67.2	76.6	74.5	70.7	73.92
M_4 - 75% RDF of NPK + 25% N-Urban Compost	66.9	64.3	61.7	64.3	73.6	70.7	67.9	70.73
M_5 - 50% RDF of NPK + 50% N-Urban Compost	74.6	70.6	66.4	70.5	82.1	77.7	73.0	77.59
Mean	69.5	66.5	62.3		76.4	73.2	68.5	
	SEm±	CD (p=0.05)				SEm±	CD (p=0.05)	
M	1.47	2.74			M	2.60	4.39	
S	1.29	3.18			S	1.70	3.21	
M at S	2.20	NS			M at S	2.23	NS	
S at M	1.49	NS			S at M	1.63	NS	

site was sandy clay loam with pH of 7.6, Electrical conductivity 0.86 dSm^{-1}, low in organic carbon (0.73 dSm^{-1}), low in available nitrogen (217 kg ha^{-1}) and medium in phosphorus (64 kg ha^{-1}) and high in potassium (402 kg ha^{-1}). The experiment was laid out in a randomized block design for maize during *kharif* 2014 and 2015 with six treatments consisting of combinations of three fertilizer levels 100, 75 and 50% RDF through fertilizer and 25 and 50% RDN through two manures (FYM, Urban compost) with four replications. *Kharif* maize hybrid (DHM-117) was sown on 27th July during first year and 19th June during second year adopting a spacing of 60 × 20 cm. In general the climatic conditions were congenial during crop growth period and incidence of pest and disease attack was noticed to a some extent. The observations on soil properties viz., available N, P_2O_5 and K_2O after harvest in groundnut were taken. The observations on physic chemical properties like pH, EC, OC after harvest were also taken.

Table 3. Available K_2O (kg ha^{-1}) in post harvest soil of *rabi* groundnut after *kharif* maize as influenced by different treatments.

Treatments given to *kharif* maize (M)	Treatments given to *rabi* groundnut (S) 2014-15 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean	2015-16 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean
M_1 - 100% RDF of NPK	386.4	379.6	367.8	377.9	398.0	391.0	378.8	389.3
M_2 - 75% RDF of NPK + 25% N-FYM	393.5	384.1	370.6	382.7	405.3	395.6	381.7	394.2
M_3 - 50% RDF of NPK + 50% N-FYM	398.4	391.2	376.4	388.7	410.4	402.9	387.7	400.3
M_4 - 75% RDF of NPK + 25% N-Urban Compost	396.4	387.4	372.4	385.4	408.3	399.0	383.6	397.0
M_5 - 50% RDF of NPK + 50% N-Urban Compost	405.6	395.4	384.7	395.2	417.8	407.3	396.2	407.1
Mean	396.1	387.5	374.4		407.9	399.2	385.6	
	SEm±	CD (p=0.05)				SEm±	CD (p=0.05)	
M	3.47	7.07			M	3.60	7.39	
S	3.09	8.18			S	3.80	8.51	
M at S	3.20	NS			M at S	3.23	NS	
S at M	2.49	NS			S at M	2.63	NS	

Table 4. The pH in post harvest soil of *rabi* groundnut after *kharif* maize as influenced by different treatments.

Treatments given to *kharif* maize (M)	Treatments given to *rabi* groundnut (S) 2014-15 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean	2015-16 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean
M_1 - 100% RDF of NPK	7.84	7.83	7.82	7.83	7.85	7.83	7.83	7.84
M_2 - 75% RDF of NPK + 25% N-FYM	7.83	7.83	7.83	7.83	7.84	7.84	7.84	7.84
M_3 - 50% RDF of NPK + 50% N-FYM	7.85	7.84	7.83	7.84	7.85	7.83	7.84	7.84
M_4 - 75% RDF of NPK + 25% N-Urban Compost	7.86	7.85	7.84	7.85	7.87	7.84	7.83	7.85
M_5 - 50% RDF of NPK + 50% N-Urban Compost	7.87	7.86	7.85	7.86	7.88	7.87	7.84	7.86
Mean	7.85	7.84	7.83		7.86	7.84	7.84	
	SEm±	CD (p=0.05)				SEm±	CD (p=0.05)	
M	0.17	NS			M	0.14	NS	
S	0.09	NS			S	0.10	NS	
M at S	0.10	NS			M at S	0.12	NS	
S at M	0.13	NS			S at M	0.13	NS	

Results and Discussion

Available nitrogen (kg ha^{-1})

In both the years, significantly higher available nitrogen in soil was observed due to application of 50% RDF+50% RDN through urban compost (M_5) higher than that of 75% RDF+25% RDN through farmyard manure (M_2), 100% RDF (M_1) and 75% RDF+25% RDN through urban compost (M_4) and was comparable with 50% RDF+50% RDN through farmyard manure (M_3) in preceding maize residual treatments. Significantly lower available N in soil was recorded with application of 100% RDF (M_1) in both the years (Table 1). Addition of FYM or urban compost in these treatments might have maintained surface soil structure favorable for easy penetration of pegs and better development of pods through increased supply of essential nutrients. The available N, P_2O_5, K_2O and S were significantly higher in legume based cropping systems during both the season of the study than non legume system was reported by Vidyavathi et al. [2]. The increment was higher in case of organic manures alone mainly due to slow release of nutrients through organic manures and enriching available pool of nitrogen. Whereas, combined application of organics and chemical fertilizer noticed comparatively lower per cent increase this may be because of rapid mineralization due to higher microbial activity which provided readily available nutrients to plants.

During both the years of study, fertilizer levels exerted a significant influence on available soil nitrogen of succeeding groundnut and it was the highest with 100% RDF (S_1), which was however, comparable with 75% RDF (S_2) and significantly superior to 50% RDF (S_3). With regard to interaction between residual treatments and fertilizer levels was not observed during both years of study.

Available phosphorus (kg ha^{-1})

In both the years, significantly higher available phosphorus in soil was observed due to application of 50% RDF+50% RDN through urban compost (M_5) higher than that of 75% RDF+25% RDN through farmyard manure (M_2), 100% RDF (M_1) and 75% RDF+25% RDN through urban compost (M_4) and was comparable with 50% RDF+50% RDN through farmyard manure (M_3) in preceding maize residual treatments (Table 2). Significantly lower available phosphorus in soil was recorded with application of 100% RDF (M_1) in both the years. The build up of available phosphorus was higher in these organic manure treated plots, it might be due to release of organic acid during microbial decomposition of organic matter which might

Table 5. EC (dSm^{-1}) in post harvest soil of *rabi* groundnut after *kharif* maize as influenced by different treatments.

Treatments given to *kharif* maize (M)	Treatments given to *rabi* groundnut (S) 2014-15 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean	2015-16 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean
M_1 - 100% RDF of NPK	0.86	0.85	0.86	0.86	0.87	0.86	0.83	0.85
M_2 - 75% RDF of NPK + 25% N-FYM	0.85	0.84	0.83	0.84	0.85	0.85	0.85	0.85
M_3 - 50% RDF of NPK + 50% N-FYM	0.84	0.84	0.82	0.83	0.84	0.83	0.82	0.83
M_4 - 75% RDF of NPK + 25% N-Urban Compost	0.85	0.83	0.83	0.84	0.86	0.84	0.84	0.85
M_5 - 50% RDF of NPK + 50% N-Urban Compost	0.84	0.84	0.84	0.84	0.83	0.82	0.82	0.82
Mean	0.85	0.84	0.84		0.85	0.84	0.83	

	SEm±	CD (p=0.05)		SEm±	CD (p=0.05)
M	0.07	NS	M	0.06	NS
S	0.09	NS	S	0.01	NS
M at S	0.02	NS	M at S	0.02	NS
S at M	0.05	NS	S at M	0.06	NS

have helped in the solubility of native phosphates, thus increased available phosphorus pool in the soil. Available phosphorus was higher (32.14 kg ha^{-1}) when poultry manure was applied continuously on nitrogen equivalent basis. The results also indicated that DTPA extractable Fe and Zn was found to be deficient in all the treatments whereas Cu and Mn seem to be sufficient in all the treatments [3].

During both the years of study, fertilizer levels exerted a significant influence on available soil phosphorus of succeeding groundnut and it was the highest with 100% RDF (S_1), which was however, comparable with 75% RDF (S_2) and significantly superior to 50% RDF (S_3). With regard to interaction between residual treatments and fertilizer levels was not observed during both years of study.

Available potassium (kg ha^{-1})

In both the years, significantly higher available potassium in soil was observed due to application of 50% RDF+50%RDN through urban compost (M_5) higher than that of 75% RDF+25% RDN through farmyard manure (M_2), 100% RDF (M_1) and 75% RDF+25% RDN through urban compost (M_4) and was comparable with 50% RDF+50% RDN through farmyard manure (M_3) in preceding maize residual treatments. Significantly lower available potassium in soil was recorded with application of 100% RDF (M_1) in both the years (Table 4.64). Similar beneficial effect of organic manures on the available K_2O content of soil was reported earlier in case of FYM and urban compost. Whereas, in case of organic manure + fermented urban waste there was slight reduction in the available potassium content compared to former treatments which may be ascribed to the higher mineralization of K_2O contributing to its availability due to quick build up of micro flora and fauna by liquid manure (Table 3) [4] which helped for rapid mineralization. Similarly after harvest of *rabi* crop, significantly higher available K_2O content in soil was recorded in treatments with either organic manures alone or in combination with fermented urban manures due to beneficial effect of organic manures through slow release and rapid mineralization by fermented organics through build up of micro flora and fauna. The integrated nutrient management practice recorded significantly higher available N (278.4 kg/ha), P_2O_5 (23.4 kg/ha), K_2O (355.0 kg/ha) and S (18.7 kg/ha) when compared to chemical nutrient management practice. Similarly, DTPA extractable Zn, Fe, Mn and Cu were significantly influenced by integrated nutrient management practice (1.46, 7.96, 9.67 and 0.89 mg/kg, respectively). At the end of fourth of LTFE, there was increase in available N by 19.0, P_2O_5 by 46.3, K_2O by 9.6 and S by 54.1% respectively due to INM. Similarly DTPA extractable Zn, Fe, Mn and Cu increased by 18.5, 30.6, 36.5 and 30.0% re-

Table 6. OC (%) in post harvest soil of *rabi* groundnut after *kharif* maize as influenced by different treatments.

Treatments given to *kharif* maize (M)	Treatments given to *rabi* groundnut (S) 2014-15 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean	2015-16 Recommended dose of fertilizer (%) 100 (S_1)	75 (S_2)	50 (S_3)	Mean
M_1 - 100% RDF of NPK	0.73	0.74	0.74	0.74	0.74	0.71	0.79	0.74
M_2 - 75% RDF of NPK + 25% N-FYM	0.75	0.74	0.72	0.74	0.73	0.73	0.72	0.73
M_3 - 50% RDF of NPK + 50% N-FYM	0.76	0.74	0.73	0.74	0.75	0.75	0.74	0.75
M_5 - 75% RDF of NPK + 25% N-Urban Compost	0.75	0.75	0.74	0.75	0.74	0.73	0.74	0.74
M_5 - 50% RDF of NPK + 50% N-Urban Compost	0.76	0.76	0.75	0.76	0.76	0.75	0.77	0.76
Mean	0.75	0.75	0.74		0.74	0.73	0.75	
	SEm±	CD (p=0.05)				SEm±	CD (p=0.05)	
M	0.07	NS			M	0.06	NS	
S	0.09	NS			S	0.01	NS	
M at S	0.020	NS			M at S	0.02	NS	
S at M	0.04	NS			S at M	0.06	NS	

spectively due to integrated nutrient management practice over their initial values was reported by Vidyavathi et al. [2].

During both the years of study, fertilizer levels exerted a significant influence on available soil potassium of succeeding groundnut and it was the highest with 100% RDF (S_1), which was however, comparable with 75% RDF (S_2) and significantly superior to 50% RDF (S_3). With regard to interaction between residual treatments and fertilizer levels was not observed during both years of study.

Physico chemical properties
of post harvest soil

During both the years, the soil pH, EC and OC after harvest of succeeding *rabi* groundnut did not differ significantly due to different fertilizer levels with FYM or urban compost to *kharif* maize and 50, 75 and 100% RDF to succeeding *rabi* groundnut as well as their interaction (Tables 4—6). There was no significant difference among FYM and urban compost irrespective of fertilizer level. The pH and EC of the soil varied from 8.29 to 8.59 and 0.08 to 0.17 dS m^{-1}. Soil pH and EC values were not influenced markedly by different integrated nutrient management treatments. Continuous application of organic manures either singly or in combination with inorganic fertilizers showed the higher organic carbon content when compared to inorganic fertilization alone [3].

Conclusions

Post harvest available (N, P and K) content after *kharif* maize was significantly higher with 50% RDF+50% RDN through urban compost (T_6) on par with 50% RDF+ 50% RDN through FYM (T_4). Physicochemical properties of soil were not significantly influenced by different treatments during both the years.

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