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INFLUENCE OF LONG-TERM APPLICATION OF FERTILIZERS AND MANURE ON SOIL NUTRIENT STATUS AND YIELD OF GROUNDNUT

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ABSTRACT

An experiment on long -term application of fertilizers and manure on soil properties and yield of rain fed groundnut mono cropping system was initiated in the year 1981 during *kharif* season at Regional Agricultural Research Station, Tirupati, Andhra Pradesh, India. The same experiment was used for the present investigation during *kharif,* 2018 season, to study the influence of long-term application of fertilizers and manure on soil nutrient status and yield of groundnut. The experiment has eleven treatments each replicated four times in a randomized block design. The treatments include T_1: Control (no manure or fertilizers), T_2 : Farm yard manure @ 5 t ha^{-1} (once in 3 years), T_3: 20 kg nitrogen (N) ha^{-1}, T_4: 10 kg phosphorus (P) ha^{-1}, T_5: 25 kg potassium (K) ha^{-1}, T6: 250 kg gypsum ha^{-1}at flowering stage, T_7: 20 kg N + 10 kg P ha^{-1}, T_8: 20 kg N + 10 kg P + 25 kg K ha^{-1}, T_9: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum ha^{-1} at flowering stage, T_{10}: 20 kg N + 10 kg P + 25 kg K + 100 kg lime ha^{-1} at flowering stage, T_{11}: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum ha^{-1}at flowering stage+ 25 kg zinc sulphate ha^{-1} (as basal, once in 3 years). Incorporation of chemical fertilizers in combination with N since 38 years had significantly influenced the available nitrogen content of the soil. However, the soil available nitrogen was in deficient range in all the treatments. The soil available phosphorus was depleted in all the treatments at both depths over a period of 38 years except in only P and NPK+lime (T_{10})at surface (0-15 cm)in which observed a little increase in available P. Similarly, soil available potassium was depleted as compared to initial potassium and the decrease was noticed with the treatments where K is not included and available K was higher in the treatments where potassium was included as compared that of other nutrients during *kharif*, 2018.The application of NPK (20:10:25 kg ha^{-1}) + lime (100 kg ha^{-1}) recorded significantly higher pod yield followed by NPK+ gypsum, NPK, and NPK+ gypsum+ $ZnSO_4$ and haulm yield was high in NPK+gypsum and NPK+gypsum+ $ZnSO_4$. The results revealed that there is a significant influence of long- term use of manure and fertilizers on the productivity of rainfed groundnut and soil nutrient status in Alfisols of Chittoor district

KEYWORDS: Groundnut, long-term fertilizer use, crop yield, soil nutrient status

INTRODUCTION

The history of the long- term manurial experiments in India dates back to 1885 with the establishment of the first permanent manurial experiment based on the Rothamsted model at Kanpur (Uttar Pradesh). The succeeding decade saw the establishment of two more such experiments one at Pusa (Bihar) in 1908 and the other at Coimbatore (Tamil Nadu) in 1909.

Long- term fertilizer experiments play an important role in understanding the changes in physical, physico-chemical and chemical properties and productivity of the crop. The decline in soil fertility due to the imbalance fertilizers use has been recognized as one of the most important factors limiting crop yield. It is well recognized that long term fertilizer experiments are repositories of valuable information regarding the sustainability of intensive agriculture. . The LTFE serves as an important tool to understand the changes in soil properties due to intensive cropping and continuous fertilization. Consistent use of fertilizers and manures in soil alerts the physical, physico-chemical and chemical properties -

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of the soil. Long term fertilizer experiments are normally intended to show how high a production can be reached under different condition and how far the soils are able to with stand depletion and deterioration.

Rainfed groundnut crop holds a key position among the oil seed crops grown in Andhra Pradesh state in India with an area of 16.22 lakh ha and with a production of 14.57 lakh tonnes and productivity of 898 kg ha^{-1}. India stands first in area and second in production and fifth in productivity of groundnut. The productivity of groundnut is low in India in general and Andhra Pradesh in particular due to rain dependency (85%), monoculture (60%) and cultivation on marginal soils of low fertility. However, the crop is grown in several parts of the country under rainfed conditions as a monocrop. The accumulation and depletion of nutrients over a long period has an impact on productivity and sustainability. Hence the present investigation was taken up to assess the effect of long-term fertilization on soil nutrient status and yield of groundnut grown in Alfisols of Chittoor district.

MATERIALS AND METHODS

The present investigation was carried on Alfisols (Typic Rhodustalf) at Regional Agricultural Research Station, Tirupati, Chittoor district of Andhra Pradesh during the season *kharif*, 2018, in the field in which long-term fertilizer experiment was initiated during 1981 *i.e.*, 37 years after the initiation of the experiment (The initial soil parameters: pH - 6.7, E.C.- 0.08 dSm-1, O.C.% - 0.178, P2O5 – 47.6 kgha-1 and K2O – 216 kgha-1). The experiment involved 11 treatments each replicated four times in a randomized block design. The treatments include T_1: Control (no manure or fertilizers), T_2 : Farm yard manure @ 5 t ha^{-1} (once in 3 years), T_3: 20 kg Nitrogen (N) ha^{-1}, T_4: 10 kg Phosphorus (P) ha^{-1}, T_5: 25 kg Potassium (K) ha^{-1}, T6: 250 kg gypsum ha^{-1}, T_7: 20 kg N + 10 kg P ha^{-1}, T_8: 20 kg N + 10 kg P + 25 kg K ha^{-1}, T_9: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum ha^{-1} at flowering stage, T_{10}: 20 kg N + 10 kg P + 25 kg K + 100 kg lime ha^{-1} at flowering stage, T_{11}: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum ha^{-1} + 25 kg zinc sulphate ha^{-1} (as basal, once in 3 years). The nutrients NPK were applied through the fertilizers like urea, single super phosphate and muriate of potash. The farmyard manure and $ZnSO_4$ were not applied in this season. The test crop was groundnut, variety Dharani. The crop was sown on 16-07-2018 and harvested on 19-11-2018.The soil samples were collected at harvest at 0-15 cm and 15-30 cm as per treatments and analyzed for major soil available nutrients. Soil available nitrogen was determined by alkaline permanganate method (Subbaiah and Asija, 1956), phosphorus by (Olsen *et al*., 1954) and available potassium by Jackson (1973). Yield and yield attributes were recorded after harvest of the crop. Data was analyzed statistically for test of significance following the Fisher's method of analysis of variance as outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Major nutrients

Available nitrogen (kg ha^{-1})

Soil available nitrogen at harvest was significantly influenced due to different treatments in both the surface and subsurface layers. With regard to the surface soil available nitrogen content (kg ha^{-1}) varied from 62.72 to 87.81. Significantly the highest soil available nitrogen was recorded in NPK+lime (87.81) and on par with NPK+ gypsum+Zn(84.67). Whereas, the lowest value was recorded in gypsum alone treatment (62.72) followed by control (65.86). At subsurface soil, available nitrogen content varied from 68.99 to 87.81 kg/ha. Significantly the highest soil available nitrogen was recorded in NPK+ gypsum treated plot (87.81) and the lowest was recorded in control (68.99).

From the results (Table-1 and Fig.1) it could be noticed that the available nitrogen was said to be low irrespective of the treatments studied as per the rating chart given by Muhr *et al.*(1965). From the above said results, it was clear that in surface layer, the highest value of available nitrogen was recorded in NPK+lime treatment which was on par with NPK+ gypsum+$ZnSO_4$ and with respect to the subsurface soil the highest was recorded in NPK+ gypsum treated plot followed by only FYM and only N treatments. Higher amount of N was registered with the application of chemical fertilizers in combination with N. This was mainly due to the application of the nitrogenous fertilizers continuously over a period of 38 years in the present study. Similar results were earlier reported by Kundu *et al.* (2017) that the available nitrogen content differed widely between the control and other treatments. These findings are in accordance with Sreenivasarao *et al.*(2013), Parvathi *et al.* (2015) and Madhuri *et al*. (2017).

Available phosphorus (P_2O_5 kg ha^{-1})

Soil available phosphorus content at harvest (Table 1) was significantly influenced by different treatments in both the surface (0-15 cm) and subsurface soil (15-30 cm). The available phosphorus content of the surface soil ranged from 33.3 to 57.7 with a mean value of 45.55. However, significantly highest value was observed in only P (57.7) which was on par with NPK+ lime (52.6). Whereas lowest value was observed in control (33.3)

In the sub surface soil, it ranged from 39.8 to 19.2 with a mean value of 29.49. However, significantly highest value was observed in only P (39.8) and the lowest was observed in control (19.2).

Depletion of available P was seen in all the treatments(Fig.2) as compared with initial recorded in 1981 (47.6) except in P alone treatment and NPK+ limewhere observed a little increase in available P in soil. The depletion of available P was mainly due to the crop uptake since 38 years irrespective of its application from soil. This situation is ascribed to lower dose of P application to crop (10 kg P ha^{-1}) against the recommended dose of 17.5 kg P ha^{-1} and the formation of tricalcium phosphate might be due to the presence of considerable amount of calcium. Similar results were earlier reported by Parvathi *et al*. (2015), Yamini *et al*. (2015) and Salma *et al.* (2017).

Available potassium(kg ha^{-1})

Soil available potassium content at harvest (Table-1) was significantly influenced at the surface (0-15 cm) and was not influenced in the subsurface soil (15-30 cm) by various treatments used in the long-term experiment. Available potassium of the surface soil ranged from 109 to 209 kg ha^{-1} with a mean value of 151. The surface soil available potassium content was significantly higher in K alone treated plot (209) and followed by NPK (207). Whereas, the lowest was observed in only gypsum (109).

The available potassium content in subsurface soil was ranged from 120 to 163 kg ha^{-1} with a mean value of 144.27. Among various treatments, the highest value was recorded with NPK treated plot(163). The lowest available potassium was obtained in control (120).

The critical analysis of the data (Fig.3) indicated that available K content of the soil decreased in all the treatments studied during *kharif*, 2018 as compared to - the initial status (216 kg K ha^{-1}) recorded in the year, 1981. This decrease in available K was mainly due to the more uptake of K from the soil. The higher uptake of K was might be due to the getting higher haulm and pod yield in some of the *kharif* seasons in which favourable environmental conditions prevailed.Intensive cropping with high yielding crop varieties led to depletion of K from soil which was evident from a number of long-term field experiments conducted across the country under AICRP program of ICAR (Anand, 2002).

Yield and yield attributes of groundnut

The yield and yield attributes (Table 2) were significantly influenced by the various treatments used in the study. The higher 100 pod weight was obtained in NPK+lime treatment whereas the higher 100 kernel weight was obtained in NPK treatment. However, highest shelling percentage was obtained in only gypsum.

From the data presented in Table 2, it could be noticed that the pod yield of groundnut was significantly influenced by different treatments. The highest pod yield of groundnut was recorded in NPK+lime treatment (2163 kg ha^{-1})followed by NPK+ gypsum, NPK, and NPK+ gypsum+ $ZnSO_4$whereas lowest yield was recorded in control (1605 kg ha^{-1}).

Interestingly, FYM alone treated plot (@ 5 t ha^{-1} once in three years recorded higher pod yield which was on par with the aforesaid treatments. The lowest pod yield of groundnut was obtained with the control which was significantly inferior over the rest of the treatments. The highest pod yield obtained in this study with NPK+lime treatment might be attributed to the adequate and balanced supply of the nutrients like N, P, K, Ca, S to meet the requirements of the crop during the crop growth period.The similar findings were reported by Babu *et al.* (2007). Lalfkzuala *et al.* (2008) reported the beneficial effects of NPK+FYM on pod yield of groundnut over control on sandy loam soils. Similar results were also reported by Parvathi *et al.* (2015).

The haulm yield of groundnut (Table 2) significantly influenced by different treatments. The highest haulm yield was recorded in NPK+ gypsum treatment (4279 kg ha^{-1}) which was on par with NPK+ gypsum+ $ZnSO_4$, only P and NPK + limewhereas lowest haulm yield was observed in control (2113 kg ha^{-1}). This might due to the application of nutrients in balanced proportion during the early stages of the crop growth produces vigorous plants due to better availability of nutrients which in turn resulted in higher biomass which in turn favoured the improvement in haulm yield (Abraham and Thenua, 2010). Similar results were reported by Akbari *et al.* (2010) and Madhuri *et al.* (2017).The plots which received single nutrients *i.e.,* N or P or K alone and control are inferior as compared to the combined application of nutrients. This shows the requirement of all the nutrients for better crop growth and yields.

From the present study, it is clear that nutrients application is essential for higher yields in groundnut crop grown under rain fed conditions on Alfisols and FYM application on long-term is needed to sustain the yields. Further, balanced application of all the nutrients are very important for groundnut grown as rain fed crop.

Table 1. Effect of long-term application of fertilizers and manure on soil available major nutrients of surface and subsurface layers at harvest, *kharif*, 2018

Treatments	Avail N kg/ha^{-1}		Avail P_2O_5 kg/ha^{-1}		Avail K_2O kg/ha^{-1}	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
T_1: Control	65.86	68.99	33.3	19.2	129	120
T_2: Only FYM @ 5t/ha^{-1} once in three years	65.86	84.67	38.6	32.1	150	142
T_3: Only N @ 20 kg/ha^{-1}	81.54	84.67	37.2	27.1	125	133
T_4: Only P @ 10 kg/ha^{-1}	78.4	75.26	57.7	39.8	118	140
T_5: Only K @ 10 kg/ha^{-1}	72.13	81.54	48.9	24.4	209	150
T_6: Only gypsum @ 250 kg/ha^{-1} at flowering	62.72	84.67	44.9	20.5	109	138
T_7: N P	78.4	84.67	47.5	29.4	134	143
T_8: NPK	75.26	78.4	48.7	33.3	207	163
T_9: NPK+ gypsum	75.26	87.81	47.5	32.1	164	147
T_{10}: NPK+lime @ 100 kg/ha^{-1} as basal	87.81	78.4	52.6	33.2	142	151
T_{11}: NPK+gypsum+ $ZnSO_4$ @ 25 kg/ha^{-1} once in three years	84.67	78.4	44.2	33.3	174	160
Initial 1981	**NA**	**NA**	**47.6**	**NA**	**216**	**NA**
CD @ 5%	**13.73**	**8.48**	**10.31**	**6.08**	**56.05**	**19.3**
SEm±	**4.73**	**2.92**	**3.55**	**2.09**	**19.3**	**6.65**

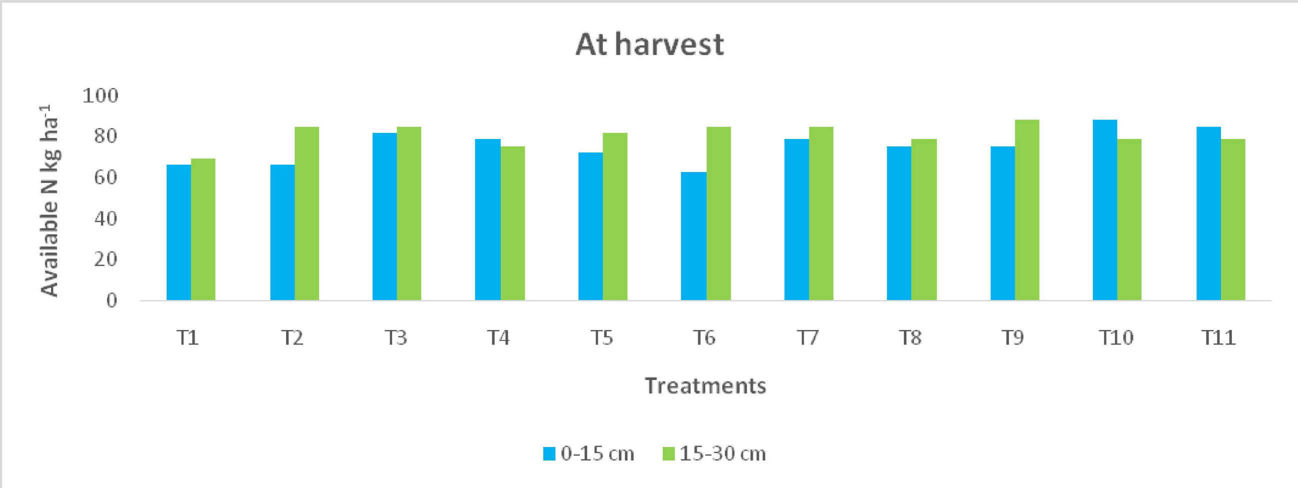

Fig.1. Effect of long-term application of fertilizers and manure on soil available nitrogen (kg ha^{-1}) at harvest of surface and subsurface *kharif,* 2018

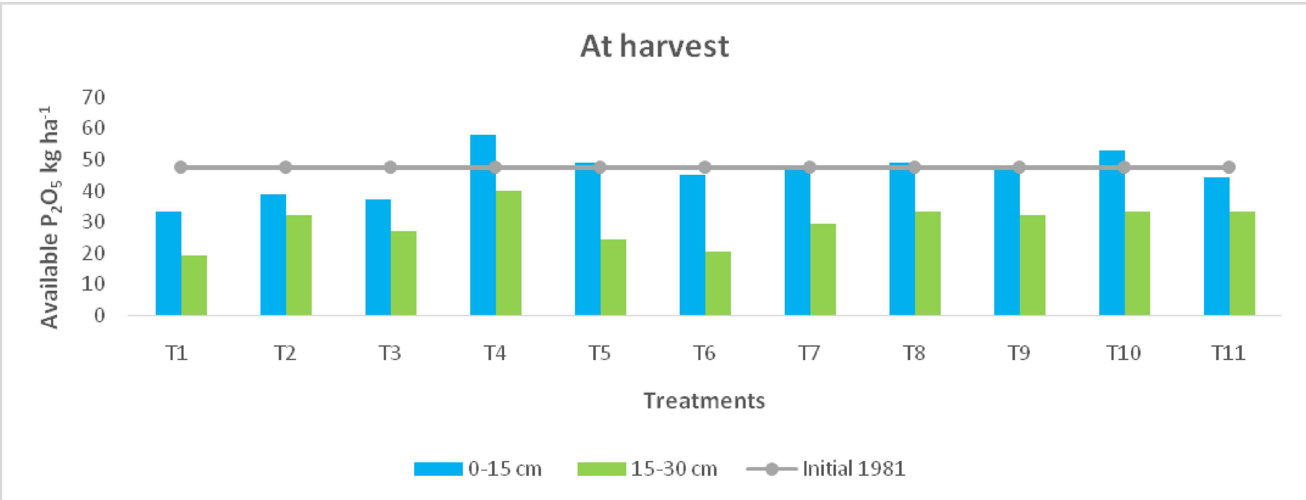

Fig. 2. Effect of long-term application of fertilizers and manure on soil available phosphorus (kg ha^{-1}) at harvest of surface and subsurface *kharif,* 2018

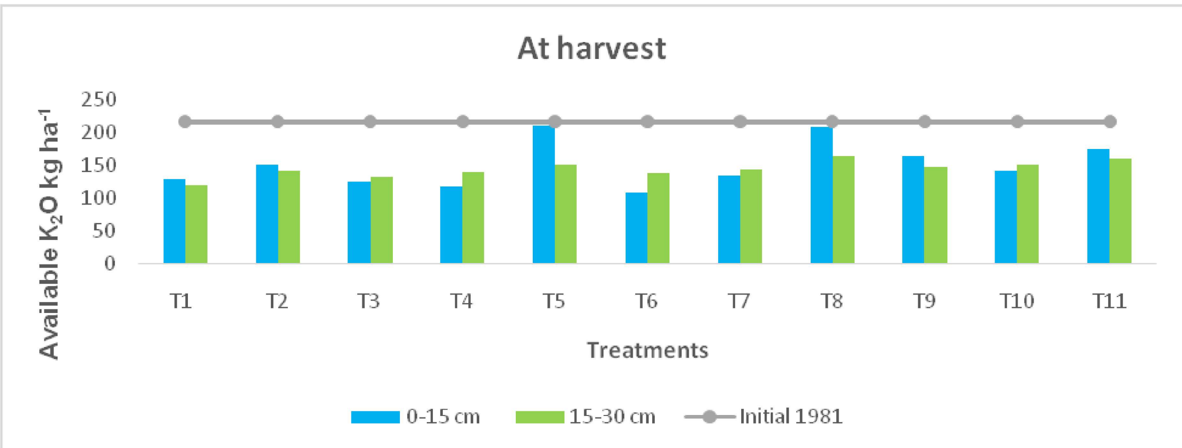

Fig. 3. Effect of long-term application of manure and fertilizers on soil available potassium (kg ha^{-1}) at harvest of surface and subsurface *kharif,* 2018

Fig. 3. Effect of long-term application of manure and fertilizers on soil available potassium (kg ha^{-1}) at harvest of surface and subsurface *kharif,* 2018

Treatments	100 pod wt (g)	100 kernal wt (g)	Shelling (%)	Haulm yield (kg/ha)	Pod yield (kg/ha)
T1: Control	87.49	36.87	68.62	2113	1605
T2: Only FYM	95.7	42.44	73.85	3589	1900
T3: Only N	90.82	38.6	72.85	2689	1679
T4: Only P	91.23	40.57	73.43	3831	2026
T5: Only K	89.19	39.31	68.63	2542	1710
T6: Only gypsum	88.5	40.1	76.88	2384	1763
T7: N & P	83.26	39.37	74.83	3431	1868
T8: NPK	94.25	42.5	71.4	3979	1984
T9: NPK+ gypsum	93.29	41.06	70.73	4279	2157
T 10: NPK+Lime	100.14	42.04	71.7	3484	2163
T11: NPK+Gypum+ Zn	89.48	38.47	71.03	4052	2147
CD @5%	**6.74**	**3.03**	**NS**	**993**	**277**
SEm±	**2.32**	**1.04**	**3.41**	**342**	**95.3**

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