Long-term Effect of Manure and Fertilizers on Yield and Nutrient Uptake of Groundnut Grown in Alfisols of Chittoor District in Andhra Pradesh, India

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Abstract

The present investigation was under taken during *kharif* 2011 season, to study the effect of long-term application of manure and fertilizers on pod yield, haulm yield and nutrient uptake of groundnut crop. The experiment was initiated in the year 1981 during *kharif* season at Regional Agricultural Research Station, Tirupati, Andhra Pradesh, India. The results revealed that application of NPK (20:10:25 kg ha^{-1}) + gypsum (250 kg ha^{-1}) + $ZnSO_4$ (25 kg ha^{-1}) recorded significantly higher pod and haulm yield in groundnut. Further, the uptake of N, P, K, Ca, Mg and S in haulm, kernel and shell at harvest in the treatment NPK+ Gypsum + $ZnSO_4$ was found to be at par with NPK (20:10:25 kg ha^{-1})+gypsum (250 kg ha^{-1}). The results revealed that there is significant influence of long term use of manure and fertilizers on the productivity of rainfed groundnut and soil nutrient status in alfisols of Andhra Pradesh.

Keywords: groundnut, alfisol, long-term fertilizer use, crop yield, nutrient uptake

Introduction

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. Accumulation of nutrients in monocropping system of groundnut under rainfed conditions depends upon the amount of nutrients supply to the soil through different sources viz., organic and inorganic sources on the long-term. 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 yield and nutrient uptake of groundnut grown in alfisols of Chittoor district.

Materials and Methods

The present investigation was carried in Alfisols (Typic Rhodustalf) out at Regional Agricultural Research Station, Tirupati, Chittoor district of Andhra Pradesh during the season Kharif, 2011, in the field in which long-term fertilizer experiment was initiated during the season ie., 30 years after the initiation of long-term fertilizer experiment in 1981

(The initial soil parameters: pH - 6.7, E.C.- 0.08 dSm^{-1}, O.C.% - 0.178, P_2O_5 – 47.6 $kgha^{-1}$ and K_2O – 216 $kgha^{-1}$). The experiment involved 11 treatments each replicated four times in a randomized block design. The treatments includes T1: Control (no manure and fertilizers), T2: Farm yard manure 5 t ha^{-1} (once in 3 years), T3: 20 kg N ha^{-1}, T4: 10 kg P ha^{-1}, T5: 25 kg K ha^{-1}, T6: 250 kg gypsum ha^{-1}, T7: 20 kg N + 10 kg P ha^{-1}, T8: 20 kg N + 10 kg P + 25 kg K ha^{-1}, T9: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum at flowering stage, T10: 20 kg N + 10 kg P + 25 kg K + 100 kg lime ha^{-1} at flowering stage, T11: 20 kg N + 10 kg P + 25 kg K + 250 kg gypsum + 25 kg $ZnSO_4$ (as basal, once in 3 years) ha^{-1}. The nutrients NPK were applied through the fertilizers like urea, single super phosphate and muariate of potash. The farmyard manure and $ZnSO_4$ were not applied in this season. The test crop was groundnut, variety Narayani. The crop was sown on 11-07-2011 and harvested on 28-10-2011.

The plant samples (haulms, kernels and shells) were collected at harvest and ground in willey mill and stored in labeled butter paper covers for further analysis. Total nitrogen in plant sample was determined by Modified Kjeldahl's method by using Kel plus digestion and distillation units (Piper, 1996). Diacid extract (9:4 mixture of HNO_3+$HClO_4$) was prepared as per the method outlined by Jackson (1973). This diacid extract was used to determine P, K, Ca, Mg and S contents in haulms, kernels and shells. P and K (Jackson, 1973) and Ca, Mg and S (Vogel, 1978) were estimated by using standard methods and nutrient uptake was calculated.

Statistical Analysis

The data was statistically analyzed following the ANOVA analysis of variance for randomized block design. Statistical significance was tested with 'F' test at 5 per cent level of probability and compared the treatmental means with critical difference.

Results and Discussion

Pod and Haulm Yield of Groundnut

The highest pod yield of 1499 kg ha^{-1} was obtained with application of NPK (20:10:25 kg ha^{-1}) + gypsum (250 kg ha^{-1}) + $ZnSO_4$ (25 kg ha^{-1}) which was found to be on par with the NPK (20:10:25 kg ha^{-1}) + gypsum (250 kg ha^{-1}) and FYM alone treatments whereas lowest yield was obtained in the control (1204 kg ha^{-1}) (Table 1). However, the highest haulm yield (2593 kg ha^{-1}) was noticed with the application of FYM alone treatment which was on par with NPK (20:10:25 kg ha^{-1}) + gypsum (250 kg ha^{-1}) + $ZnSO_4$ (25 kg ha^{-1}) whereas lowest haulm yield was obtained in gypsum alone treated plot (Table 1). This indicates that for sustainability of yields, integrated use of organic and inorganic fertilizers is essential. This is further substantiated by the results of Kishore et al. (2007) who reported that conjunctive use of NPK, gypsum and $ZnSO_4$ are advantageous for achieving higher production of pod and haulm yield in groundnut crop.

N, P and K Uptake at Harvest

The highest uptake of N in haulms and kernels was noticed in NPK + gypsum + $ZnSO_4$ i.e. 49.85 and41.76 kg ha^{-1} respectively which was on par with NPK + gypsum. In shells, maximum uptake was found in N alone treatment which was on par with NPK + gypsum + zinc sulphate (Table 2). The results are well matched with the findings reported by Bhaskara et al. (1992). The uptake of P was highest in haulms with gypsum alone treatment (5.21 kg ha^{-1}), followed by kernels in NPK + gypsum + $ZnSO_4$ (3.26 kg ha^{-1}) and the lowest in shells in NPK + gypsum (0.83 kg ha^{-1}) treatments. However, the treatments with gypsum had the highest uptake of P than the other treatments (Table 2). This could be attributed to increase in P concentration due to the application of S and Ca. It was in agreement with the findings of Chandrasekhara and Krishnamoorthy (1984). However, the uptake of K highest in haulms in NPK+lime (60.96 kg ha^{-1}) followed by in kernels with NPK + gypsum + $ZnSO_4$ (14.84 kg ha^{-1}) and in shells with NPK +gypsum (7.62 kg ha^{-1}) treatments.

The treatments receiving K fertilizer along with N, P, gypsum, $ZnSO_4$ and lime had shown higher uptake of potassium than the other treatments whereas the K application alone also influenced the uptake of K (Table 3). Addition of S through all the sources i.e., SSP, gypsum and $ZnSO_4$ increased the K uptake by haulm, kernels and shells. This might be due to synergistic effect of S on K absorption. This was supported by the findings of Vijayraj and Arunsathe (1983).

Table 1 Effect of long-term application of manure and fertilizers on pod and haulm yield of groundnut crop (Kharif, 2011; Parvathi et al., 2013)

Treatment	Pod yield	Haulm yield
	(---------- kg ha^{-1}----------)	
T1: Control (No manure and fertilizers)	1204	2153.0
T2: Farm yard manure 5 t ha^{-1} once in 3 years	1373	2593.0
T3: 20 kg N ha^{-1}	1354	2432.0
T4: 10 kg P ha^{-1}	1357	2520.0
T5: 25 kg K ha^{-1}	1281	2157.0
T6: 250 kg gypsum ha^{-1}	1266	2084.0
T7: 20kg N+10kgP ha^{-1}	1262	2310.0
T8: 20kg N+10kgP+25 kg K ha^{-1}	1338	2413.0
T9: 20kg N+10kgP+25 kg K+250 kg gypsum ha^{-1}	1467	2455.0
T10: 20kg N+10kgP+25 kg K+100 kg lime ha^{-1}	1342	2509.0
T11: 20kg N+10kgP+25 kg K+250 kg gypsum +25 kg $ZnSO_4$ ha^{-1}	1499	2543.0
GM	1340	2379.0
SEm±	56	66.2
CD (P=0.05)	163	191.1

Table 2 Effect of long-term application of manure and fertilizers on uptake of nitrogen (kg ha^{-1}) and phosphorus (kg ha^{-1}) at harvest (Kharif, 2011)

Treatment	N (kg ha^{-1})			P (kg ha^{-1})		
	Haulm	Kernel	Shell	Haulm	Kernel	Shell
T1: Control (No manure and fertilizers)	31.81	26.09	6.79	3.16	1.91	0.31
T2: Farm yard manure 5 t ha^{-1} once in 3 years	43.28	31.85	6.77	4.54	2.45	0.46
T3: 20 kg N ha^{-1}	38.18	33.51	7.89	4.13	1.68	0.33
T4: 10 kg P ha^{-1}	46.67	31.08	6.41	4.03	1.83	0.26
T5: 25 kg K ha^{-1}	36.23	28.28	5.57	3.67	3.01	0.57
T6: 250 kg gypsum ha^{-1}	39.39	30.90	5.97	5.21	2.38	0.29
T7: 20kg N+10kgP ha^{-1}	35.30	37.68	5.14	3.37	2.03	0.55
T8: 20kg N+10kgP+25 kg K ha^{-1}	42.05	38.12	5.90	4.71	2.07	0.34
T9: 20kg N+10kgP+25 kg K+250 kg gypsum ha^{-1}	46.40	41.10	7.31	2.82	2.05	0.83
T10: 20kg N+10kgP+25 kg K+100 kg lime ha^{-1}	42.14	36.55	6.40	4.39	2.38	0.50
T11: 20kg N+10kgP+25 kg K+250 kg gypsum +25 kg $ZnSO_4$ ha^{-1}	49.85	41.76	7.84	3.83	3.26	0.73
GM	41.03	34.26	6.50	3.99	2.28	0.47
SEm±	1.55	1.81	0.40	0.21	0.28	0.07
CD (P=0.05)	4.48	5.23	1.17	0.61	0.81	0.19

Ca, Mg and S Uptake at Harvest

The highest uptake of Ca in haulms, kernels and shells noticed in NPK + gypsum + $ZnSO_4$ *i.e.* 71.63 kg ha^{-1}, 1.63 kg ha^{-1} and 3.78 kg ha^{-1}respectively. In general, the calcium uptake increased due to application of Ca and S (Tables 3 and 4). It might be attributed to increase in the availability of Ca and S in fruiting and rooting zones and also beneficial effect of S on the uptake of Ca. These results were in agreement with the findings of Bhaskara et al. (1992).

Table 3 Effect of long-term application of manure and fertilizers on uptake of potassium (kg ha^{-1}) and calcium (kg ha^{-1}) at harvest (Kharif, 2011)

Treatment	K (kg ha^{-1})			Ca (kg ha^{-1})		
	Haulm	Kernel	Shell	Haulm	Kernel	Shell
T1: Control (No manure and fertilizers)	39.67	9.53	5.38	45.46	1.01	2.22
T2: Farm yard manure 5 t ha^{-1} once in 3 years	45.79	13.22	5.87	56.05	1.29	2.07
T3: 20 kg N ha^{-1}	44.41	12.02	5.58	53.50	1.09	2.03
T4: 10 kg P ha^{-1}	46.52	11.59	5.24	60.96	1.19	2.69
T5: 25 kg K ha^{-1}	51.20	10.83	6.41	53.31	1.06	2.60
T6: 250 kg gypsum ha^{-1}	46.68	11.50	4.86	48.40	1.27	2.41
T7: 20kg N+10kgP ha^{-1}	51.74	11.80	4.92	49.52	1.22	2.10
T8: 20kg N+10kgP+25 kg K ha^{-1}	54.05	11.57	7.00	62.57	1.07	2.71
T9: 20kg N+10kgP+25 kg K+250 kg gypsum ha^{-1}	38.50	12.60	7.62	60.18	1.32	2.51
T10: 20kg N+10kgP+25 kg K+100 kg lime ha^{-1}	60.96	10.18	6.46	54.01	0.99	2.37
T11: 20kg N+10kgP+25 kg K+250 kg gypsum +25 kg $ZnSO_4$ ha^{-1}	56.72	14.84	7.58	71.63	1.63	3.78
GM	48.75	11.79	6.08	55.96	1.19	2.59
SEm±	4.16	0.74	0.51	3.32	0.08	0.22
CD (P=0.05)	12.00	2.12	1.46	9.59	0.23	0.64

Table 4 Effect of long-term application of manure and fertilizers on uptake of magnesium (kg ha^{-1}) and sulphur (kg ha^{-1}) at harvest (Kharif, 2011)

Treatment	Mg (kg ha^{-1})			S (kg ha^{-1})		
	Haulm	Kernel	Shell	Haulm	Kernel	Shell
T1: Control (No manure and fertilizers)	15.47	2.45	1.01	3.34	1.37	0.90
T2: Farm yard manure 5 t ha^{-1} once in 3 years	20.23	3.39	1.14	6.85	1.87	0.65
T3: 20 kg N ha^{-1}	21.60	2.82	0.90	8.22	1.84	1.17
T4: 10 kg P ha^{-1}	22.55	2.92	0.94	5.04	1.97	1.21
T5: 25 kg K ha^{-1}	17.60	2.58	1.00	4.42	1.88	1.12
T6: 250 kg gypsum ha^{-1}	15.89	2.80	0.83	6.16	1.60	0.77
T7: 20kg N+10kgP ha^{-1}	19.37	2.93	0.86	5.72	1.79	0.71
T8: 20kg N+10kgP+25 kg K ha^{-1}	20.90	2.86	1.04	5.66	1.81	0.85
T9: 20kg N+10kgP+25 kg K+250 kg gypsum ha^{-1}	23.06	3.14	1.14	8.37	2.41	1.55
T10: 20kg N+10kgP+25 kg K+100 kg lime ha^{-1}	19.93	2.51	0.85	6.86	1.69	0.93
T11: 20kg N+10kgP+25 kg K+250 kg gypsum +25 kg $ZnSO_4$ ha^{-1}	21.00	3.51	1.16	9.82	2.15	1.23
GM	19.87	2.90	0.99	6.40	1.85	1.01
SEm±	1.37	0.19	0.08	0.73	0.18	0.17
CD (P=0.05)	3.96	0.54	0.24	2.11	0.52	0.49

Maximum uptake of Mg in haulms was found with NPK + gypsum (23.06 kg ha^{-1}) treatment whereas in kernels (3.51kg ha^{-1}) and shells (1.16 kg ha^{-1}) was noticed with NPK + gypsum + $ZnSO_4$ treatment. The treatment of NPK, gypsum and lime combinations had the highest Mg uptake than the others as these treatments produced higher dry matter production. Further, the application of Ca, P and S containing fertilizers improved the uptake of Mg. It was in agreement with the findings of Chandrasekhara and Krishnamurthy (1984).

Maximum uptake of sulphur in haulms was observed in NPK + gypsum + $ZnSO_4$ (9.82 kg ha^{-1}) treatment. In kernels (2.41 kg ha^{-1}) and shells (1.55 kg ha^{-1}) with NPK + gypsum application recorded the highest uptake. The treatments receiving sulphur through SSP, gypsum and $ZnSO_4$ along with P and N had the highest uptake of sulphur than other individual treatments. These results were in agreement with the findings of Bhaskara et al. (1992) and Nayak et al. (2004).

Conclusions

Long term application of manure and fertilizers had significant effects on yield of groundnut in rainfed monocropping system including soil fertility status. Decreased pH over a period of time in chemical fertilizer applied plots indicating the hazardous acidification of soils and which is not the case with the FYM applied treatments. Significant difference in pod yield among the treatments control (no application) in particular, points to the use of chemical fertilizers in combination with gypsum and $ZnSO_4$ in rainfed groundnut for sustainable higher productivity in this southern agro-climatic zone.

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