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EFFECT OF SLOW RELEASE NITROGEN AND PHOSPHORUS FERTILIZER SOURCES IN COCONUT GROWING COASTAL SANDY SOIL

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Effect of a few slow release N and P fertilizers in a coconut growing coastal sandy soil under Kasaragod conditions was studied for four years (1984-88) in a randomised block design. Soil and leaf analysis in the initial year and closing year showed that there was about 67 per cent increase in available P at 0-25 cm layer only with single super phosphate application. This trend was not seen with Mussorie phosphate. In the case of potassium, enrichment of K occurred in most of the treatments at 0-25 and 25-50 cm depth. In the leaf nutrients, no significant difference between treatments was recorded in N, P and K. Urea formaldehyde continued to release ammonia up to 70 days. Significant difference between treatments and intervals were recorded in nitrate nitrogen. In urea N, significant differences between treatments, interval and interaction were recorded. Among the P fractions saloid bound P and Al-P recorded significant differences between treatments.

INTRODUCTION

Influence of various organic and inorganic fertilizers on soil properties in young coconut gardens grown on coastal sandy soil was reported by Joshi *et al.*, (1982) and Nambiar *et al.*, (1983). In another study, Nambiar *et al.*, (1988) also reported the effect of blending of coconut coir dust with fertilizers (NPK) on the changes in carbon and nitrogen fractions. Bopaiah and Biddappa (1987) reported the results of investigations conducted on the coastal sand, red sandy loam and laterite soils with four slow release nitrogen sources for their nitrogen release pattern under laboratory conditions. Information on the effect of different inorganic nitrogen sources, water soluble and acid soluble phosphorus sources on coastal sandy soil is lacking. A study was initiated to investigate the effects of the above nitrogen and phosphorus sources under the existing conditions of Kasaragod.

MATERIALS AND METHODS

A field experiment was laid out during 1984 in coastal sandy soil on 10 year old coconut palms at the Central Plantation Crops Research Institute, Kasaragod. The trial was in randomised block design with ten treatment combinations replicated four times. The treatments were applied in the month of June from 1985 to 1988. The coastal sandy soil (quartzipsaments) analysed 0.1 per cent organic carbon, 41 kg available nitrogen, 19 kg available phosphorus, 8.2 kg available potassium and pH measuring 6.5. The soil contained 98.2 per cent sand, 0.2 per cent silt, 0.7 per cent clay and its water holding capacity was 20.4 per cent.

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Composite samples were drawn from all the six treatment blocks from 0-25 and 25-50 cm at 0, 15, 30, 45 and 70 days interval for estimating nitrogen and phosphorus fractions after treatments were applied. Urea, ammoniacal and nitrate nitrogen were determined as per the procedure described by Onkan and Sundarman (1977). The samples were analysed for P fractions according to the method of Chang and Jackson (1967). The leaf samples were collected from (N+1)/2 leaf (frond) in the month of May. The leaf nitrogen was determined by the micro kjeldahl method and phosphorus and potassium in the diacid extract by colorimetry and flame photometric methods respectively. The treatment details are as follows :

T1 - Urea 1.1 kg + single super phosphate (SSP) 2 kg + muriate of potash (MOP) 2kg

T2 - Urea 1.1 kg + Mussorie phosphate (Mu.Phos) 1.6 kg + MOP 2 kg

T3 - Ureaformaldehyde (UF) 1.50 kg + SSP 2 kg + MOP 2 kg

T4 - UF 1.50 kg + Mu.Phos 1.6 kg + MOP 2 kg

T5 - Lac coated urea (LC/U) 1.47 kg + SSP 2 kg + MOP 2 kg

T6 - LCU 4.4 kg + Mu.Phos 1.6 kg + MOP 2 kg

T7 - Urea 0.97 kg coated with 0.3 kg neem cake + tar + SSP 2 kg + MOP 2 kg

T8 - Urea 0.97 kg+ Neem cake 0.3 kg + tar + Mu.Phos 1.6 kg + MOP 2 kg

T9 - Urea 0.97 kg with coir dust 17.5 kg + SSP 2 kg + MOP 2 kg

T10 - Urea 0.97 kg + coir dust 17.5 kg + Mu.Phos 1.6 kg + MOP 2 kg

RESULTS AND DISCUSSION

The mean values of available nitrogen, phosphorus and potassium at the beginning and at the end of the experiment are presented in Table 1. Available nitrogen level increased in all the treatments over the initial levels irrespective of the treatments, the highest being 76.8 per cent in T9 (coir dust 17.5 kg with urea 0.97 kg + P + K). However, there was no significant difference between treatments both at 0-25 and 25-50 cm depths. A general lowering of available nitrogen was recorded in all the treatments at lower depth. The nitrogen values at 25-50 cm depth were higher at the end of the trial compared to

Table 1. Mean values of available N, P & K in the soil at the initial and closing stages of the experiment

Treatment	0 - 25 cm depth						25 - 50 cm depth					
	N (ppm)		P (ppm)		K (ppm)		N (ppm)		P (ppm)		K (ppm)	
	1985	1989	1985	1989	1985	1989	1985	1989	1985	1989	1985	1989
T1	44.8	63.8	58.9	154.0	42.8	71.3	34.0	42.8	46.6	61.6	26.3	33.0
T2	48.3	62.7	80.7	62.9	57.8	39.8	36.3	47.3	60.5	58.0	26.5	42.3
T3	33.5	65.5	64.6	108.5	19.5	18.8	26.0	39.3	62.2	77.1	18.3	28.3
T4	34.5	66.0	64.1	49.6	29.5	26.5	28.5	37.5	48.0	32.6	16.0	24.8
T5	47.3	62.3	70.5	124.0	33.8	38.8	32.8	38.5	52.5	59.5	28.5	18.5
T6	41.5	57.5	70.8	54.9	36.3	40.0	31.5	40.5	51.2	66.5	23.8	31.3
T7	38.8	65.3	62.1	112.0	27.8	57.3	28.5	47.0	39.8	78.8	18.5	35.8
T8	35.0	63.3	57.1	45.8	26.8	82.8	25.8	47.3	32.8	34.4	21.0	44.0
T9	37.5	66.3	09.0	113.0	34.8	44.8	32.5	39.8	61.6	75.8	26.0	31.0
T10	46.0	61.0	75.3	45.8	35.5	39.5	38.3	48.3	48.4	42.6	27.8	22.8
CD(P = 0.05)		N.S.	—	39.7	—	27.40	—	N.S.	—	26.93	—	N.S.

N.S. Not significant

the initial values showing movement of nitrogen to the lower horizon.

Available phosphorus (Bray-I) level showed significant difference between treatments at the end of the experiment both at 0-25 cm and at 25-50 cm depths, the values ranging from 45.8 to 154.0 ppm and 32.6 to 79.8 ppm respectively. At 0-25 cm depth, T1 recorded the highest P and was higher than all other treatments except T5. In the 25-50 cm depth, T7 recorded the highest value and treatments T1 to T6 and T9 were on par with it. Phosphorus level has increased over the period (four years) in treatments supplied with single super phosphate only, the increase being about 67 per cent at 0-25 cm, and 9.8 per cent at 25-50 cm depth, whereas Mussorie phosphate treated plots showed decrease in the level of P upto 17 per cent in the surface layer. The available P at 25-50 cm depth was higher than the initial level at this layer but was less than the top layer in general. Looking into the P concentration at the two depths, it can be surmised that single phosphate renders more available P as compared to Mussorie phosphate and that phosphorus mobilised to the lower depth in about four years.

With regard to available K, significant difference was recorded in the closing year at 0-25 cm depth. Treatment T8 recorded significantly higher values of K than all other treatments except T1 and T2. Barring a few treatments, all other treatments showed enrichment of potassium in four years both at 0-25 and 25-50 cm depths. This supports the findings of Nambiar *et al.*, (1989) wherein three year application of potassium has increased potassium level in the soil under high density multispecies cropping system. Enrichment of potassium in Alfisol by rotation of four seasonal crops was also reported by Yaduvamshi *et al.*, (1985).

Leaf nutrient concentrations (NPK) in different treatments at the initial stage and during the year of closing are presented in Table 2. It can be observed that there has been no significant difference between treatments in respect of nitrogen, phosphorus and potassium levels in coconut leaves. The leaf nitrogen level did not change from the initial level whereas phosphorus concentration improved slightly reaching the critical limit. The potassium concentration remained at the same lėvel as compared to the initial level. In all these three nutrients, the concentration remained above the criticical level (Manciot *et al.*, 1979). The effect of applied nitrogen was not clearly reflected in

Table 2. Leaf N, P, K levels at the initial and closing stages of experiment

Treatment	Nitrogen (%)		Phosphorus (%)		Potassium (%)	
	1985	1989	1985	1989	1985	1989
T1	2.06	1.72	0.120	0.134	1.55	1.61
T2	2.21	1.80	0.109	0.128	1.79	1.38
T3	2.11	1.76	0.119	0.130	1.59	1.80
T4	1.95	1.68	0.117	0.128	1.59	1.80
T5	1.97	1.81	0.124	0.124	1.48	1.45
T6	2.02	1.75	0.119	0.124	1.73	1.51
T7	1.81	1.83	0.125	0.122	1.56	1.59
T8	2.07	1.84	0.119	0.121	1.60	1.64
T9	1.88	1.70	0.118	0.126	1.54	1.53
T10	1.88	1.90	0.127	0.124	1.60	1.59
C.D.	—	N.S.	—	N.S.	—	N.S.

N.S. Not significant

Table 3. Mean values of nitrogen fractions in different slow release N sources with progress of time (days)

Treatment	Urea nitrogen (ppm)						Ammoniacal nitrogen (ppm)						Nitrate nitrogen (ppm)					
	0	15	30	45	70	Mean	0	15	30	45	70	Mean	0	15	30	45	70	Mean
T1	1.87	4.10	2.63	5.28	2.19	3.21	86.2	27.9	56.4	31.1	42.2	48.76	8.62	10.92	14.63	17.99	16.25	13.68
T2	1.36	3.98	2.43	4.77	1.55	2.82	60.8	14.8	15.8	10.2	33.9	27.10	14.34	13.70	12.29	15.68	15.51	14.30
T3	1.94	10.60	3.52	8.81	2.39	5.45	27.3	15.4	10.1	16.9	21.9	18.32	4.60	5.76	3.02	6.47	6.53	5.28
T4	4.56	12.85	9.30	13.13	7.92	9.55	39.3	11.2	6.3	20.4	14.8	18.40	10.70	7.59	3.60	10.99	7.22	8.02
T5	4.06	10.87	8.82	5.36	1.97	6.20	11.4	31.3	17.7	26.1	24.4	42.98	7.40	3.21	3.81	8.87	10.76	6.81
T6	2.06	11.99	1.60	4.79	1.80	4.45	90.8	46.9	16.0	31.2	29.2	42.82	8.90	6.28	8.73	12.60	11.45	9.59
T7	1.22	5.27	1.79	3.03	2.00	2.66	71.8	28.9	15.6	15.3	36.8	33.68	9.13	13.13	11.20	10.88	10.59	10.99
T8	1.87	4.75	2.37	1.60	2.48	2.61	71.3	34.3	24.3	24.3	11.1	33.06	13.02	10.31	12.61	13.23	12.17	12.27
T9	0.85	4.47	1.73	2.53	2.84	2.50	80.5	42.0	67.9	55.5	75.3	64.28	8.13	11.88	10.90	10.49	11.11	10.50
T10	2.22	7.26	1.89	3.66	1.83	3.37	72.8	26.0	11.2	11.8	30.9	30.54	19.46	13.62	10.10	8.51	15.71	13.48
Mean	2.21	7.61	3.59	5.29	2.67	—	71.62	27.87	24.13	24.28	32.05	—	10.43	9.64	9.09	11.57	11.72	—

Urea nitrogen: CD for interval - 4.30; CD for interaction - 13.59; CD for treatment - 5.55

Ammoniacal nitrogen: CD for interval - 13.544; CD for interaction - 13.5444; CD for treatment - 17.486

Nitrate nitrogen: CD for interval - 2.019; CD for interaction - 6.386; CD for treatment - 2.607

the leaf probably due to the coarse texture of soil and low organic matter content which make the nutrients unavailable to roots due to high permeability.

N fractions

Urea nitrogen, ammoniacal nitrogen and nitrate nitrogen released under different treatments at various intervals are given in Table 3. On the day when different sources of nitrogen were applied, ammoniacal nitrogen was released in lac coated urea followed by coir dust blended urea, while it was significantly low in ureaformaldehyde. Ureaform continued to release ammoniacal nitrogen at all the intervals, upto the seventieth day. During the entire period, a maximum release of ammoniacal nitrogen was recorded with coir dust mixed urea. However, it is noteworthy that Mussorie phosphate appeared to reduce the release of ammoniacal nitrogen from different sources.

Significant difference between treatments were recorded at 0, 15, 30, 45 and 70 days intervals in respect of nitrate nitrogen. Significant difference between intervals was also recorded for this parameter. Maximum accumulation of nitrite N was recorded with T1 and T2 (urea) followed by T7 and T8. The nitrate nitrogen was minimum in T3 and T4 (ureaform). This is obvious due to the low ammoniacal N released from its sources. The result is in accordance with the findings of Bopaiah and Biddappa (1987) and Brown and Volk (1966).

In respect of urea N, significant differences between treatments, intervals and interaction were recorded. Significant level of urea N was released on the 25th day and 45th day compared to the first and the last day. Maximum urea N was recorded in treatments applied with ureaform and neem cake coated urea.

Table 4. Effect of various treatments on Phosphorus fraction in the soil (0.25 cm)

Treatment	Saloid bound P. (ppm)		Al-P (ppm)		Fe-P (ppm)		Reductant soluble P.		Occluded P		Ca P		Total P (Hel extr)	Available P (Bray)
	1985	1989	1985	1989	1985	1989	1985	1989	1985	1989	1985	1989		
T1	10.0	37.5	40.0	94.0	80.0	205.3	63.3	54.3	7.5	15.4	12.0	111.4	552.50	15.4
T2	28.0	18.3	68.0	55.3	104.0	231.5	45.5	44.7	7.0	16.4	86.0	83.6	557.50	62.8
T3	64.0	36.5	57.0	94.5	102.0	162.8	33.3	68.9	6.5	9.14	3.0	72.0	462.50	108.
T4	65.0	12.5	31.0	29.3	81.0	259.0	53.3	67.5	5.0	7.5	25.0	207.3	637.50	49.6
T5	24.0	30.8	43.0	77.0	163.0	132.5	37.0	41.0	4.0	8.5	49.0	91.8	430.0	124.6
T6	11.0	14.8	57.0	39.8	106.0	190.0	40.0	58.9	6.5	8.5	90.0	90.4	677.50	54.9
T7	8.0	28.0	36.0	55.8	66.0	152.0	63.3	50.6	8.5	8.8	21.5	71.0	447.50	112.3
T8	9.0	15.5	51.0	38.8	94.0	137.0	33.3	46.2	9.5	12.4	66.5	85.4	545.00	45.8
T9	6.5	88.3	27.0	124.5	30.0	130.0	23.3	55.4	17.5	8.1	9.0	77.9	712.50	113.8
T10	11.0	23.8	42.0	33.0	68.0	163.0	27.0	55.6	10.0	13.4	31.0	163.8	610.00	45.8
Mean	23.65	30.6	45.2	64.2	98.8	195.3	41.9	54.3	8.2	10.8	43.3	106.1	—	
CD (P = 5%)	—	34.69	—	40.15	—	NS	—	NS	—	NS	—	NS	NS	

NS - Not significant

Correlation : Total P >< saloid P - r = 0.2628 NS
" >< AlP - r = 0.0513 NS
" >< Fe P - r = 0.6799*

Total P >< Reduct. P - r = 0.3625 NS
" >< Occluded P - r = 0.0643 NS
" >< Ca P - r = 0.3582 NS

P fractions

Various fractions of P in the soil as affected by different treatments over its pre-treatment concentrations are given in Table 4. Out of the fractions determined, only saloid bound P and Al-P recorded significant differences between treatments. Treatment T9 (coir dust with 0.97 kg N + 2 kg SSP + 2 kg MOP) recorded significantly higher value of saloid bound P than all other treatments and the least being in T4 (Ureaform + P and K). With regard to Al-P, treatment T1, T3 and T9 recorded significantly higher amounts than the other treatments. However, in general, all the P fractions increased over its initial P level by the close of the experiment. Among various fractions, Fe-P recorded maximum values at the commencement and at the end of the experiment. It can be seen that, Ca-P recorded higher rate of (43%) increase at the close of the experiment against its pre-treatment concentration compared to the other fractions. Reductant soluble and occluded P formed the least among the fractions studied. The total P ranged from 430 to 712 ppm at the end of the experiment. An attempt to work out the correlations of different P-fractions with that of total P indicated that except Fe-P (r =0.6799**) there was no significant correlation with the other fractions.

From the foregoing discussion, it can be concluded that the nutrients (NPK) build up by constant use of their sources in sandy soils. Mussorie phosphate is equally efficient as super phosphate in sandy soil, though Khan *et al.* (1985) have indicated that rock phosphate is the ideal and cheap carrier of P for coconut in laterite soil. Among the slow release N fertilizers, ureaform, neem cake coated urea and coir dust mixed with urea have been found to remain for a longer period in the sandy soil, thus facilitating availability of N in the more permeable soil.

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