NOTES ON THE MANURING OF COCONUT PALMS*

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1. RESULTS OF EXPERIMENTS.

THE results of the field experiments and laboratory investigations on which manurial recommendations are made will be first considered. These include, among others, an experiment on a comparatively good soil at Bandirippuwa Estate that had been regularly manured, and two field experiments on poor lateritic (cabooky) soils at Veyangoda and Ahangama.

(*a*) *Experiment at Bandirippuwa Estate : Good Soil.*—This was laid down in November, 1935, and the following conclusions can be drawn :—

(i.) *Phosphoric Acid.*—In no year has phosphoric acid given an increase in yield. Analyses of soil samples taken in 1935 before manuring showed that there was a considerable accumulation of available phosphoric acid in the manure circles as a result of previous manuring. Even after a period of 8 years, during which no phosphoric acid was applied, the reserves of this constituent were found to be sufficient.

(ii.) *Nitrogen.*—In the second year after the first manuring nitrogen gave a highly significant increase. In most of the subsequent years nitrogen applied at the rate of 0·5 lb. per palm produced an increase, which however, was not statistically significant in some years, whereas a higher dose of 1 lb. per palm depressed this increase of yield. There was little difference between inorganic nitrogen manures, such as cyanamide and organic manures, such as groundnut cake in their effect on yield.

(iii.) *Potash.*—Potash applied at the rate of 0·75 lb. per palm produced a significant response only in the fifth year after the first manuring. With the higher dose of 1·5 lbs. potash per palm a significant increase was produced in the third year. The response to both single and double doses of potash has been progressively increasing and reached a peak in the seventh year.

Manures were applied once in two years.

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The following Table summarises the increases of yield due to potash manuring :—

Lbs. Copra per Acre.

Year after 1st Manuring.	Increase due to 0·75 lb. potash per palm.	Increase due to 1·5 lbs. potash per palm.
1936—1st year ..	26 (not significant)	.. 50 (not significant)
1937—2nd ,, ..	47 do.	.. 80 do.
1938—3rd ,, ..	47 do.	.. 114 do.
1939—4th ,, ..	28 do.	.. 120 do.
1940—5th ,, ..	190	.. 249
1941—6th ,, ..	122	.. 196
1942—7th ,, ..	352	.. 470
1943—8th ,, ..	300	.. 407
1944—9th ,, ..	362	.. 546
Total (9 years) ..	1,474	.. 2,232
Average per annum ..	163	.. 248

Under the conditions of the experiment, potash is the dominant manurial requirement of coconut palms. Compared to nitrogen, which showed a maximum increase of 8 per cent., potash has given increases of as much as 25 per cent. for the smaller rate of application and 39 per cent. for the higher.

Palms in plots receiving no potash show visible signs of potash deficiency in the foliage and the crown.

(*b*) *Experiments at Veyangoda and Ahangama: Poor Soils.*—In contrast to the soil of the above experiment the soils of these two experiments consist of extremely poor lateritic gravel, with little reserves of plant food, subject always to heavier rainfall. In fact both these estates had not been manured for almost a decade before the commencement of the experiment.

In comparison with the results of manuring obtained in the experiment at Bandirippuwa, the yield increases observed in these two experiments have been more spectacular as shown by the data below :—*

The following points became apparent from the above two tables :—

(i) A marked response to manuring is obtained on these poor soils, in contrast to that on good soils ;

(ii.) *Phosporic Acid produces a distinct response,* which is almost spectacular considering the small amount of phosphoric acid added. In fact absence of phosphoric acid forms a definite limiting factor to the response of added nitrogen and potash. Those soils contained only traces of available phosphate ; and

(iii.) an appreciable improvement was obtained in the copra out-turns.

* Ahangama—Southern Province—Manure first applied April, 1939 and subsequently once in two years.

Treatments.	1st Year, 1939–1940. Nuts per Acre.	Lbs. Copra p. Ac.	%	Copra out-turn	2nd Year, 1940–1941. Nuts per Acre.	Lbs. Copra p. Ac.	%	Copra out-turn	3rd Year, 1941–1942. Nuts per Acre.	Lbs. Copra p. Ac.	%	Copra out-turn	4th Year, 1942–1943. Nuts per Acre.	Lbs. Copra p. Ac.	%	Copra out-turn	5th Year, 1943–1944. Nuts per Acre.	Lbs. Copra p. Ac.	%	Copra out-turn.
0	1148	478	100	1344	714	299	100	1338	920	408	100	1264	1197	508	100	1320	1100	476	100	1295
NK	1142	490	103	1306	1203	562	188	1197	1771	809	199	1225	1558	744	146	1173	1646	774	162	1190
NPK	1281	553	116	1299	1329	627	210	1187	2108	998	245	1183	2297	1073	211	1199	2280	1096	230	1165
NPK-0	133	75	16	45	615	328	110	151	1188	590	145	81	1100	565	111	121	1180	620	130	130

Veyangoda—Manures first applied December, 1939.

	1940.				1941.				1942.				1943.				1944.			
0	688	246	100	1569	433	166	100	1465	932	343	100	1524	656	233	100	1579	394	161	100	1367
NK	604	221	90	1530	544	237	143	1300	1232	491	143	1404	840	318	136	1480	391	179	111	1225
NPK	611	228	83	1503	584	258	155	1270	1669	699	204	1336	1721	672	288	1435	1393	642	397	1216
NPK-0	–77	–18	–17	–66	151	92	55	195	737	356	104	188	1065	439	188	144	999	481	297	151

0 = No manure ; NK = Nitrogen and Potash ; NPK = Nitrogen, Potash and Phosphate ;
N = 0·6 lbs. per palm ; K = 1 lb. per palm ; P = 0·6 lbs. per palm.

2. AVAILABLE MANURES.

Now that the war is over inorganic nitrogen manures such as calcium cyanamide and sulphate of ammonia, which are much cheaper than organics such as groundnut cake and fishmeal, should be soon available for coconut manuring.

Manure firms supply price lists of manures in stock, stating also their compositions. In comparing the cost of manures, the unit values or the cost per ton divided by the percentage value of the manurial ingredient should be considered. Similarly in compounding manure mixtures the cost per palm should be kept in mind, as distinct from cost per ton.

It should be noted that muriate of potash now available contains 60 per cent. potash and not 50 per cent. as in the pre-war material.

The best use should be made of locally available materials of manurial value, regarding, which information will be found in Leaflet No. 9.

3. MANURE MIXTURES.

On the basis of the discussion in Section 1, the following recommendations are made for the manuring of bearing coconut palms :—

Nitrogen.—An application of *0·5 lb. Nitrogen* per palm would be considered sufficient. Excess nitrogen should be avoided.

Phosphoric Acid.—We note from our advisory correspondence that an entirely wrong impression has been created that we have been discouraging the use of phosphates in coconut estates. The fact is that, as a result of our experiments we are in a position to recommend the judicious and economical use of phosphoric acid in manuring coconuts. These recommendations are as follows :—

(*a*) Where heavy applications of phosphoric acid have been made, such as those used in the old type of manure mixtures amounting to 4 to 5 lbs. bonemeal per palm, sufficient reserves of phosphoric acid have been found to be maintained for a number of years, so that no further response to phosphoric acid is produced for sometime. In such cases, application of phosphates may be omitted for two or three manuring cycles (say 4 to 6 years).

(*b*) Where no manuring has been done for 4 or 5 years, *more particularly in lateritic and gravelly soils*, phosphoric acid produces a response, but a small rate of application is considered sufficient. An application of *0·6 lb. phosphoric* acid equivalent to 2 lbs. saphos phosphate or $2\frac{1}{2}$ lbs. bonemeal per palm would be suitable.

Potash.—1 lb. potash per palm would be an economic dose for most soils. In potash deficient soils such as cinnamon soils marine sands as in the Puttalam district littoral, and lateritic soils and gravels it may even be increased to 1·5 lbs. per palm.

Subject to the modifications suggested above, the following mixtures can be recommended to suit present conditions ; owing to the uncertain nature

of the available stocks of manures and of changing prices, it would be advisable, specially till normal conditions return, that planters consult us on the mixtures they propose to apply :—

(*a*) Sulphate of Ammonia	.. 3 lbs.	per palm
Saphos phosphate	.. 2 ,,	
Muriate of potash (60 per cent.)	.. 2 ,,	
	7 ,,	

Ash or lime should never be added to mixtures containing sulphate of ammonia.

(*b*) Calcium cyanamide	.. 3 lbs.	per palm
Saphos phosphate	.. 2 ,,	
Muriate of potash (60 per cent.)	.. 2 ,,	
	7 ,,	

Only in case sulphate of ammonia and calcium cyanamide are not available, can the following mixtures consisting of " organics " be recommended. The latter are relatively more expensive per palm, though apparently cheaper per ton.

(*c*) Groundnut cake ..	.. 7 lbs.	per palm
Saphos phosphate	.. 2 ,,	
Muriate of potash (60 per cent.)	.. 2 ,,	
	11 ,,	

(*d*) Crushed fish ..	.. 13 lbs.	per palm
Muriate of potash (60 per cent.)	.. 2 ,,	
	15 ,,	

(*e*) Groundnut cake	.. 3½ lbs.	per palm
Crushed fish ..	.. 6½ ,,	
Saphos phosphate	.. 1 ,,	
Muriate of potash (60 per cent.)	.. 2 ,,	
	13 ,,	

(*f*) Fish guano ..	.. 7 lbs.	per palm
Saphos phosphate	.. 1 ,,	
Muriate of potash (60 per cent.)	.. 2 ,,	
	10 ,,	

(*g*) *Cattle Manure.*—Where palms are manured by tethering a pair of cattle for a week, the following manures or their equivalent should be added :—

Saphos phosphate	.. 1½ lbs.	per palm
Muriate of potash (60 per cent.)	.. 1 ,,	
	2½ ,,	

(*h*) *Goat Manure* :—

Goat manure	.. 28 lbs.	per palm
Saphos phosphate	.. 1½ ,,	
Muriate of potash (60 per cent.)	.. 1½ ,,	
	31 ,,	

The above rates of application are to be used once in two years. Half the quantity may be used if manured annually—See Sec. 7.

(i.) *Manuring Land under Cover Crops.*—In an experiment on the manuring of land under cover crops at Bandirippuwa Estate it was found that a complete mixture containing nitrogen, phosphoric acid and potash gave the best results. It is known that leguminous cover crops take up a considerable amount of phosphoric acid, Absence of potash produced a big drop in yield and here again the importance of potash for coconut manuring has been demonstrated.

Manure mixtures *a* and *b* of section 3 may be used, the quantities per palm being applied for each square.

The manure mixture is broadcast on the cover, harrowed, and the cover and manure dug over with mamoties. Ploughing in the cover with manure is very difficult even after harrowing. The cover may be envelope forked along with manure, but this under present conditions would be expensive. Where labour is insufficient for turning in covers by mamoty-digging or the cost of mamoty-digging is prohibitive, the cover may be well harrowed along with manures.

In the course of the experiment mentioned, the growth of the cover crop before turning in produced a sharp decline of yield which reached a peak in the third year. On gravelly soils, particularly in view of prolonged droughts leaving a cover crop untreated for a long time, say over 2 years, cannot be recommended.

Cover crops can also be used as manure by lightly grazing cattle and tethering the animals at night. On hilly lands subject to erosion the treating of cover crops should be done with caution. Further information on cover crops will be found in Leaflet No. 3.

4. MANURING OF YOUNG PALMS.

Recommendations for the manuring of young palms will be found in in Leaflet No. 8.

5. METHODS OF APPLICATION.

No. experiments have been carried out to test the comparative value of different methods of application :—

The following notes are based on common practices :—

(*a*) *Circular Trenches.*—The common method is to apply in circular trenches 3″ wide and 6″ deep cut at a distance of 3′ from the palm.

When manuring is done by tethering cattle (Section 3 (*g*)) it is often the practice to cut the circular trench so that the whole of the soil up to the bole to a depth of 6″ is removed.

On light sandy soils and sandy loams, in order to avoid the cost of cutting the manure circle, particularly during dry weather cattle are tethered without cutting a circular manure trench (usually after sprinkling a few baskets of coir dust when available) and after 7 to 10 days' tethering, spreading the supplementary artificial manure (Section 3 (*g*)), turning the soil along with the manure with mamoties in order to cover up the manure and finally

mulching with a layer of husks or leafy ends of fronds. *This method cannot be recommended for hard gravelly and lateritic soils.*

(*b*) "*Long-Line*" *Trenches.*—In this method manures are applied between the rows of palms in trenches 10′ broad and 6″ to 9″ deep. The advantages of this method is that green manures and husks can be buried at the same time.

Cattle can also be tethered to posts fixed in such trenches.

"Long-line" trenches should not be adopted on estates which have not been manured or cultivated for a long time, where a well-developed root system is not present between the rows.

(*c*) *Broadcasting and Ploughing.*—This can only be recommended on flat lands, where the soils are of an open texture. On sloping lands subject to considerable run-off, this method involves the risk of loss of manures by erosion.

Manures may be obtained mixed. It is often preferable to obtain the individual manures and mix at the time of application. This can be done in the field as follows: The individual manures are weighed or measured out in standardised tins according to the weight per palm into a gunny bag spread on the ground, then mixed by hand and applied direct.

The manures should be uniformly applied, forked into the soil of the manure circle or trench with mamoty forks and covered with soil.

One layer of husks with the convex side facing upwards may be placed in the manure circle and covered with soil or used as a mulch on top after covering. For further details on the utilization of husks see Leaflet No. 5.

6. TIME OF APPLICATION.

Manures should be applied during the South-West and North-East Monsoons, preferably after the heavy showers are over. In districts where the South-West Monsoon is uncertain, such as Puttalam and Batticaloa, it is advisable to manure mostly during the North-East Monsoon.

7. BIENNIAL vs. ANNUAL MANURING.

It sometimes happens that manuring is followed by a drought, and the full effect of the manure not produced. It has been shown that potash manure applied to the soil is converted from an easily available (exchangeable) into a slowly available (non-exchangeable) form, when the soil is subjected to prolonged drying as occurs during droughts. There would, therefore, be a smaller risk if, instead of applying a full dose of manure in full circles or in trenches between every row once in 2 years, half this amount is applied annually in half circles or in alternative rows. In the manuring of orchard crops which like the coconut palms respond to potash, the modern idea is that potash fertilisers should be added frequently in small amounts rather than infrequently in larger amounts.

8. SELECTIVE MANURING.

Just as poor soils show a larger response to manuring compared to good soils, palms in low bearing respond to manures better than heavy bearers. Where circumstances do not permit the manuring of an entire estate or field, selective manuring of backward palms is to be recommended. Even under normal circumstances selective manuring would be judicious. The present practice of giving a uniform dose of manure to all palms seems, unscientific, as well as uneconomic, while no doubt, the application of several mixtures would involve practical difficulties.

9. IMPORTANCE OF ADEQUATE CULTIVATION.

Particular attention should be paid to this Section.

We should not ignore the importance of adequate cultivation involving tillage operations that bring about a physical improvement of the soil, particularly in relation to soil moisture, if the best results of manuring are to be obtained. There seems to be an opinion that cultivation causes root damage, and as such is disadvantages. On the other hand, the coconut root-system is such that in the process of cultivation, numerous feeding rootlets are developed from the damaged root-ends, and this would certainly stimulate the uptake of plant nutrients.

Cultivation operations aimed at the conservation of soil moisture are of the utmost importance. The first line of defence in conserving soil moisture is an adequate system of catch-water drains. The second line of defence is burying husks, particulars about which will be found in Leaflet No. 5.

Ploughing should immediately precede manuring or immediately follow. Where a full dose is applied, the entire area between the palms should be ploughed ; if half dose alternate rows corresponding to the half circle or rows.

10. LIMITATIONS OF SOIL ANALYSES.

Many requests are made for analysis of soil samples of estates for purposes of recommending manure mixtures. There seems to be a considerable amount of popular misunderstanding on the use of soil analysis. No reliable recommendations can be based on soil analysis until data correlating such analytical figures with accurately designed field experiments are available for coconut soils. So far we have some data on the phosphate needs of coconut soils as shown by such analysis, but it has severe limitations when applied to other requirements.

C. R. S. Leaflets on Coconut Manuring.

No. 3. Cover Crops Suitable for Coconut Estates.
,, 5. Utilization of Husks on Coconut Estates.
,, 8. Manuring of Young Palms.
,, 9. Locally Available Materials of Manurial Value.