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MANURES AND MANURE MIXTURES—THEIR COMPOSITION AND EVALUATION

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IN recent years considerable interest has been evinced by coconut planters all over India with a view to getting increased yields. Among other things, they very often want to know as to which of the various kinds of manures that are available in the country, they should secure and apply. In common with most other crops, coconut palms thrive best under a judicious system of manuring with proper mixtures of organic and inorganic manures. But it is rather difficult to give a direct recommendation since the coconut is grown in different types of soil under a variety of environmental conditions. Differences in the nature and properties of the soil, the extent and distribution of rainfall, duration and severity of drought conditions, availability of irrigation and drainage facilities, the cultural practices followed, the presence or otherwise of organic matter in the soil etc., apart from differences in the manurial value of the various manures themselves, call for the evolving of manurial schedules suitable for the different coconut tracts. These and other aspects of the problem of manuring of the coconut have been dealt with in fair detail by John (4). More detailed and additional data regarding the composition of the common manures, the method of evaluating manures and manure mixtures etc. are presented in this paper with the hope that it will be useful to the agriculturist to select the most economic manures or manure mixtures.

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2. COMPOSITION OF MANURES

Data regarding the composition of the principal chemical and organic manures are presented below. The manures are arranged alphabetically and according to the chief manurial ingredient contained *viz.*, nitrogenous, phosphatic, potassic, nitrophosphatic etc., for easy reference.

Name of Manure	Nitrogen N o/o	Phosphoric acid P_2O_5 o/o	Potash K_2O o/o	Lime CaO o/o
NITROGENOUS MANURES				
Ammonium nitrate	33.0—35.0	...	...	...
Ammonium sulphate	20.0—21.0	...	...	...
Cal—Nitro—(made by treating ammonium nitrate with calcium carbonate)	20-0	...	...	20.0
Cal—urea (double salt of calcium nitrate and urea)	34.0	...	...	...
Leuna salt peter, Montana salt peter or Super ammonia (ammonium sulphate-nitrate)	26.0	...	...	...
Muriate of ammonia (Ammonium chloride)	26.0	...	...	...
Nitrate of soda (Chile salt peter or synthetic sodium nitrate)	15.5—16.0	...	...	...
Nitrate of lime (calcium nitrate)	13.0—15.5	...	...	28.0
Nitro-chalk (ammonium nitrate plus carbonate of lime)	15.5	...	...	30.0
Nitrolim (Calcium cyanamide)	20.0—21.0	...	...	55.0—60.0
Urea	46.0	...	...	...
PHOSPHATIC MANURES				
Basic slag				
Grade I 80 per cent or more is available-citrate soluble	...	14.0—19.0	...	45.0
Grade II Less than 40 per cent is available—citrate soluble				
Bone ash	...	38.3	...	...
Bone phosphate	...	24.0	...	...
Mineral Phosphates:—				
Basic mineral phosphate	...	33.0	...	...
Ephos basic phosphate	...	28.8	...	...
Florida rock phosphate	...	28.0—30.0	...	...
Flour phosphate	...	23.0	...	50.0
Kosier phosphate	...	32.5	...	14.0

Name of Manures	Nitrogen N%	Phosphoric acid P_2O_5%	Potash K_2O%	Lime CaO%
Naura rock phosphate	...	32.0	...	...
Trichy phosphate	...	22.0	...	54.0
Super phosphate				
... ordinary	...	16.0	...	...
,, double	...	25.0—30-0	...	...
,, treble	...	45.0—50.0	...	...
POTASSIC MANURES				
Carbonate of potash	...	...	40.0—50.0	...
Kainite (22.0—25.0 per cent) potassium chloride and 45.0-61.0 per cent sodium chloride)	...	...	12.0—14.0	...
Muriate of potash (potassium chloride)	...	...	48.0-50.0	...
Sulphate of potash	...	...	48.0-50.0	...
Potash salts 20.0 per cent (32.0-35.0 per cent potassium chloride and 42.0–52.0 per cent sodium chloride)	...	...	20.0	...
Potash salts 30.0 per cent (48.0-51.0 per cent potassium chloride and 24.0-27.0 per cent sodium chloride)	...	...	30.0	...
NITRO — PHOSPHATIC MANURES				
A. Chemical.—				
Ammo-phos. Grade I (Mono ammonium phosphate plus ammonium sulphate)	11.0	46.0	...	...
Ammo-phos. Grade II (Diammonium phosphate plus ammonium sulphate)	16.5	20.0	...	...
Ammonium phosphate				
Mono	10.7	46.0	...	...
,, Di	17.0	53.0	...	...
Leunaphos	20.0	20.0	...	...
Niciphos	18.0	18.0	...	...
Phosphazote (Mixture of urea and superphosphate)	7.0	15.0	...	...
B. Organic.—				
Blood, dried	12.0	3.0—4.0	...	...
Blood meal	11.5	1.2	...	...

Name of Manure	Nitrogen N o/o	Phosphoric acid P_2O_5 o/o	Potash K_2O o/o	Lime Ca O o/o
Bone char	1.0	29.9	...	38.3
Bone dust	3.7	24.5	...	31.3
Bone flour	2.0-3.0	18.0—25.0	...	...
Bone flour, steamed	1.0—2-0	25.0-32.0	...	...
Bone fluff,	12.4	5.1	...	6.2
Bone guano	5.6	21.4	...	...
Bone jelly	6.0	17.0	...	17.8
Bone meal	3.5—4.5	25.0-32.0	...	...
Bones raw,	5.0	22.0	...	...
Bonemeal, steamed	4.4	23.6	...	41.8
Bone superphosphate (dissolved bones)	2.0-3.0	15.0-16.0	...	...
Fish guano	6.8	7.1	...	...
Fish meal	6.8	7.1	...	...
Hoof meal	12.8	...	...	...
Horn meal	14.0	...	...	...
Leather shavings	8.4	0.1	...	...
NITRO — POTASSIC MANURES				
Potassium Nitrate, crude	4.5	...	14.5	...
do. refined	10.5	...	37.0	...
Potazote (Mixture of potassium chloride & ammonium chloride)	11.0—13.0	...	20.0—24.0	...
PHOSPHO-POTASSIC MANURES				
A. Chemical.—				
Potassium phosphate	...	32.0—53.0	30.0—50.0	...
B. Organic.—				
Ash of:—				
Bratties (cowdung cake)	...	2.0	0.7	...
Buttends & fronds of coconut	...	2.0	3.5—5.5	...
Coconut husks	...	2.0	16.0—23.0	...
Coconut stalks	...	1.8	9.4	28.6
Kitchen (ordinary kitchen ash)	...	...	3.0	...
Paddy husk	...	0.5	0.3	...
Saw dust — soft wood	...	0.04	0.13	0.63
do — hard wood	...	0.04	0.06	1.60
Sugarcane (*Saccharum officianarum*) trash	...	0.8	2.5	...
Wood	...	1.5-2.0	4.0-6.0	25.0-35.0

Name of Manure	Nitrogen N%	Phosphoric acid P_2O_5%	Potash K_2O%	Lime CaO%
NITRO-PHOSPHO — POTASSIC MANURES				
A. Chemical.—				
Ammo-phos-Ko (made from ammonium phosphate and muriate or sulphate of potash)				
Grade I	12.0	24.0	12.0	...
Grade II	10.0	20.0	15.0	...
Grade III	10.0	30.0	10.0	...
Grade IV	12.0	16.0	12.0	...
Grade V	9.0	18.0	18.0	...
Leuna-phoska (mixture of leunaphos & potash salt)	10.0	10.0	13.0	...
Nitrophoska (made from ammonium nitrate, diammonium phosphate, and muriate or sulphate of potash)				
Grade I	16.0	16.0	21.0	...
Grade II	10.0	20.0	20.0	...
Grade III	15.0	30.0	15.0	...
B. Organic.—				
i. **Animal wastes**				
Bats guano	8.0	2.6	1.0	...
Cattle manure (farmyard manure)	0.5-1.2	0.25-0.62	0.5-1.2	...
Compost	0.8	0.9	0.8	...
Crab manure	1.6	2.8	0.6	34.0
Eri silk work litter	4.5	1.3	3.8	...
Fowl manure	0.9	1.9	0.6	...
Goat manure	2.4	0.9	2.0	...
Horse manure	0.7	0.7	0.8	...
Pig manure	3.7	3.3	0.4	...
ii. **Oil cakes**				
Castor (*Ricinus Communis*)				
Black	4.5	1.9	0.7	...
do White	6.4	2.6	1.2	...

Name of Manure	Nitrogen N o/o	Phosphoric acid P_2O_5 o/o	Potash K_2O o/o	Lime CaO o/o
Coconut (*Cocos nucifera*)	3.5	1.4	...	...
Gingelly. til, (*sesamum orientale*)	6.1	2.4	...	...
Groundnut (*Arachis Hypogaea*)	8.0	1.4	1.2	...
Illupai (*Bassia* sp.)	2.7	0.9	...	...
Linseed (*Linum usitatissimum*)	5.6	1.4	1.3	...
Marotti (*Hydnocarpus wightiana*)	3.0	1.0	1.0	...
Neem (*Azadirachta Indica*)	5.0	1.3	1.7	...
Pinnai, laurel (*Calophyllum inophyllum*)	2.7	1.1	1.6	...
Pungam (*Pogamia glabra*)	3.6	1.3	0.7	...
Safflower (*Carthamus tinctorius*)	5.8	1.5	0.8	...
Tobacco (*Nicotiana tabacum*) seed	4.5	1.8	...	...
iii. **Green manure plants, leaves etc:**				
Adathoda (*Adathoda Vasica*)	2.5	0.6	2.9	...
Avare (*Dolichos Lablab*)	0.75	0.16	0.56	0.67
Blackgram (*Phaseolus Mungovar radiatus*)	0.85	0.18	0.53	0.74
Boga (Peria kolinji) (*Tephorosia Candida*)	2.0	0.7	1.0	...
Cowgram (*Vigna unguiculata*)	2.0	0.5	1.5	...
Dhaincha (*Sesbania aculeata*)	3.5	0.6	1.2	...
Erukku (*Calatropis gigantea*)	0.42	0.12	0.37	0.2
Forest leaves (green)	1.2	0.6	0.4	...
Horsegram (*Dolichos biflorus*)	0.50	...	...	...
Indigo (*Indigofera sumatrana*) refuse	1.8	0.4	0.3	...
Indigo, wild (*Wrightinia tinctoria*)	0.8	...	...	...
,, (*Tephrosia purpurea*)	1.8	0.2	0.6	...
Konnai (*Cassia florida*)	1.6	...	...	...
Madre (*Glyricidia Maculata*)	2.9	0.5	2.8	...
Malai poovarasu (*Hibiscus tiliaceous*)	2.1	0.5	2.1	...
Prickly pear (*Opuntia dilleni*)	0.3	1.2	1.1	...
Rain tree leaves (*Enterolobium saman*)	3.3	...	1.1	...

Name of Manure	Nitrogen N °/°	Phosphoric acid P_2O_5 °/°	Potash K_2O °/°	Lime CaO °/°
Redgram (*Cajanus indicus*)	2.8	0.4	2.0	...
Sunnhemp (*Crotalaria Juncea*)	2.3	0.5	1.8	...
Sunnhemp, Wild (*Crotalaria striata*)	2.2	0.4	1.3	...
Tea prunings	2.4	0.5	1.3	...
Virali (*Dodonea Viscosa*) cuttings	1.8	0.7	1.8	...
Weeds:—				
Fern weeds	3.1	0.5	3.0	...
Green weeds	0.8	0.3	0.2	...
Sea weeds	1.1	0.3	3.0	...
iv. **Earths**				
Village earth (Pattimannu) from old village sites	0.1	0.7	1.4	...
River silt	0.3	0.4	0.7	...
Tank silt	0.3	0.3	0.3	...

3. EVALUATION OF MANURES

The market value of a manure is judged from its unit value. For this evaluation, a unit is defined as *one per cent of one ton.* One per cent (1/100) of one ton (2240 lb.) = 1/100 x 2240 = 22.40 lb. (*) Thus, for instance a nitrogenous manure containing 22.4 lb. of nitrogen in one ton of manure (or one lb. of nitrogen in 100 lb. of manure or a manure analysing 1.0 per cent nitrogen) will contain one unit, one containing 2 x 22.40 lb. of nitrogen in one ton (or 2 lb. in 100 lb. or, analysing 2 per cent nitrogen) will be equivalent to 2 units; one having 3 x 22.40 lb. in one ton (or 3 lb. in 100 lb. or analysing 3 per cent nitrogen) will correspond to 3 units and so on. The price per ton of the manure, therefore, divided by the number of units of nitrogen or the percentage analysis, will be its unit value. The unit values of other manurial ingredients of the particular manure are also calculated similarly. Thus one unit always connotes a definite amount *i. e.* 22.40 lb. of the manurial ingredient in one ton of a manure whether it be nitrogen, phosphoric acid or potash.

(*) *Note:* In order to make this and other calculations based on 'unit value' simpler, one ton is sometimes taken as 2,000 lb. instead of 2,240 lb. The calculations themselves are not in any way affected by the change. One unit in this case will correspond to 20 lb. of the manurial ingredient in 2,000 lb. instead of 22.4 lb. in 2,240 lb.

To illustrate:-

(i) A coconut grower is offered two samples of ammonium sulphate, sample A at Rs. 440 per ton and B at Rs. 408 per ton. A contains 20 per cent nitrogen and B 17 per cent. He has to decide as to which should be purchased.

As explained above, the evaluation is made by comparing the unit values of the manurial ingredient. Thus

$A = \text{Rs. } \frac{440}{20.0} = \text{Rs. } 22\text{-}0\text{-}0$ per unit.

$B = \text{Rs. } \frac{408}{17.0} = \text{Rs. } 24\text{-}0\text{-}0$ per unit.

A is really cheaper though it appears to be more costly.

(ii) A choice has to be made from three samples of superphosphates: A at Rs. 267-0-0 per ton, B at Rs. 252-0-0 per ton and C at Rs. 264-0-0 per ton. The water soluble phosphoric acid (the chief phosphoric acid of superphosphate) content of the three samples are 16.0 per cent, 14.0 per cent and 16.5 per cent respectively.

Dividing the price per ton by the percentage analysis we get:-

$A = \text{Rs. } \frac{267}{16} = \text{Rs. } 16\text{-}11\text{-}0$ per unit.

$B = \text{Rs. } \frac{252}{14} = \text{Rs. } 18\text{-}0\text{-}0$ per unit.

$C = \text{Rs. } \frac{264}{16.5} = \text{Rs. } 16\text{-}0\text{-}0$ per unit.

It is clear that sample C is to be preferred.

4. MANURE MIXTURES

Manure mixtures are usually made by mixing together suitable types and quantities of nitrogenous, phosphatic and potassic manures. Mixtures suitable for different crops and different soil types are available in the market. In fertilizer trade, these mixtures are usually described as 2-10-2; 5-10-5; 3-6-8; 4-8-6, etc. A 5-10-5 manure mixture means that in one ton of the manure, there are 5 units (5 x 22.40 lb.) of nitrogen, 10 units (10 x 22.40 lb.) of phosphoric acid and 5 units (5 x 22.40 lb.) of potash and similarly for the other combinations.

The evaluation of these manure mixtures is done on the same basis as with simple manures. But a knowledge of the prevailing unit values of the individual manurial ingredients is necessary. It would be possible to calculate the unit value of the manurial ingredients by finding out the market price of the particular manure and its percentage analysis as explained in para 3. Assuming the current price per ton of sulphate of ammonia (20 per cent nitrogen) as Rs. 410, super phosphate (16 per cent water soluble phosphoric acid) as Rs. 156 and muriate of potash (50 per cent potash) as Rs. 424, the unit values of nitrogen, phosphoric acid and potash in these manures will be Rs. 20-8-0, Rs. 9-12-0 and Rs. 8-7-8 respectively. On the basis of these unit values the

price per ton of a 5-10-5 manure mixture from sulphate of ammonia, superphosphate and muriate of potash will be:-

Manurial ingredients.	*Units per ton.*		*Price per unit.*	*Value of ingredients.*
Nitrogen	5	x	Rs. 20-8-0	Rs. 102-8-0 worth of Nitrogen
Phosphoric acid	10	x	Rs. 9-12-0	Rs. 97-8-0 worth of Phosphoric acid
Potash	5	x	Rs. 8-7-8	Rs. 42-6-4 worth of potash
			Total value	Rs. 242-6-4 per ton.

The price of other manure mixtures of different combinations can be worked out similarly.

5. MIXING OF MANURES

Enquiries are also often recieved regarding the desirability or otherwise of mixing manures and applying such mixtures to the coconut trees, instead of applying the individual manures separately. The application of manures as mixtures is often done to economise labour and thereby reduce the cost of production. But before mixing the manures the farmer should first decide about the individual manures from which the mixture is to be made. It must be clearly understood that manures should not be mixed indiscriminately, for, when certain manures are mixed, important chemical and/or physical changes take place making the manure mixture useless or even injurious to plant growth. For instance, if ammonium sulphate is mixed with burnt lime or manures containing lime *eg.* calcium cyanamide, chemical changes take place resulting in the decomposition of the ammonium sulphate and consequent loss of nitrogen as ammonia. If, however, it becomes necessary to apply both these manures, they should be applied separately to the trees and sufficient interval should be allowed between the two applications so that one of the manures gets absorbed or fixed in the soil before the other is applied thereby preventing the decomposition.

The attached table is a guide to the manures that can be mixed without any harmful effect, which should be *used immediately* after mixing and which *never* should be mixed at all.

MIXING OF MANURES.

	Ammonium phosphate.	do sulphate	Ash	Basic slag	Bone manures	Burnt Lime	Carbonate of lime	Calcium cyanamide	Common salt	Farmyard manure & composts	Guano	Mineral phosphates	Nitrate of soda	Nitro chalk	Oilcakes	Potash salts & kainite	Sulphate or muriate of potash	Superphosphate
Ammonium phosphate	MS	MS	X	X	MS	X	IM	X	IM	MS	MS	IM	IM	IM	MS	IM	MS	MS
Ammonium sulpate	MS	MS	X	X	MS	X	IM	X	IM	MS	MS	IM	IM	IM	MS	IM	MS	MS
Ash	X	X	MS	MS	MS	X	MS	X	MS	MS	X	MS	MS	MS	MS	MS	MS	X
Basic slag	X	X	MS	MS	MS	X	MS	X	MS	MS	X	MS	MS	MS	MS	MS	MS	X
Bone manures	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Burnt lime	X	X	MS	MS	MS	MS	MS	X	MS	MS	X	MS	MS	MS	MS	MS	MS	X
Carbonate of lime	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Calcium cyanamide	X	X	MS	MS	MS	MS	MS	MS	MS	MS	X	MS	MS	MS	MS	MS	MS	X
Common salt	IM	IM	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	IM
Farmyard manure & Composts	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Guano	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Mineral phosphate	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Nitrate of soda	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Nitrochalk	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Oil cakes	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Potash salts & kainite	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Sulphate or muriate of potash	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS
Superphosphate	MS	MS	X	X	MS	X	MS	X	MS	MS	MS	MS	MS	MS	MS	MS	MS	MS

MS = May be mixed and stored for some time.

IM = Can be mixed immediately before use

X = Should not be mixed.