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INTEGRATED PLANT NUTRIENT MANAGEMENT IN OIL PALM PLANTATIONS THROUGH RECYCLING OF PALM WASTES

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Long-term irrigation and fertilizer experiment revealed that application of 1200 g N, 600 g P_2O_5, 1200 g K2O per year and irrigation at 90 l per palm per day are optimum for oil palm. At present, entire nutrient demand is being supplied through chemical fertilizers. Quantification of annual addition of oil palm waste and its nutritive value has offered the scope to substitute the chemical fertilizers through proper recycling of organic waste. Different digestion techniques revealed that organic wastes were converted into good quality organic manures within a period of four months; these organic manures had a C/N ratio of $\leq$ 20:1 and nutrients of 1.6-1.85 N, 0.27-0.31 P, 0.8-1.1 K, 0.4-0.6 Ca and 0.37-0.49 per cent Mg. Among the composting methods, vermicomposting was found more effective in producing quality manure. The composted oil palm wastes could supply 175 kg N, 73 kg P_2O_5, 129 K_2O, 70 kg CaO and 71 kg MgO per ha per year.

INTRODUCTION

Large vegetative growth coupled with heavy removal of harvested bunches makes oil palm a high nutrient demanding crop. A comparatively higher dose of chemical fertilizers recommended for palm pose threat to soil health and environment. It was also reported that 41 per cent of the annual cost of cultivation of oil palm is spent on chemical fertilizers (Varghese and Nampoothiri, 1988). Nutrient content of palm parts and nutrient uptake by oil palm have been reported by Foster and Chang (1979), Turner and Gillbanks (1988) and Singh (1989). However, no work has been reported on the potential of nutrient supply through composting of oil palm wastes into organic manure. The present study was conducted to investigate the scope of substituting a part of the chemical fertilizers through recycling of palm wastes available from the plantation as a non-monitory input of plant nutrients. The study was conducted with a view to (a) estimate the kind and quantity of waste materials and byproducts available in an oil palm plantation, (b) determine the nutrient content and available quantity of nutrients and (c) assess suitable composting methods of converting these wastes materials to organic manure for recycling in integrated nutrient management (IPNM) system.

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MATERIALS AND METHODS

Data were collected from the long-term irrigation and fertilizer experiment on oil palm plantation, Palode, Central Plantation Crops Research Institute. The irrigation treatments consisted of three levels viz., (1) no irrigation (2) 45 l and (3) 90 l per palm per day supplied through drip system. There were four levels of fertilizer combinations viz., (1) no fertilizer, (2) 600:300:600, (3) 1200:600:1200 and (4) 1800:900:1800 g N:P_2O_5:K_2O per palm per year applied in two equal split applications. Among the treatments, irrigation at 90 l per day and fertilizer at 1200:600:1200 g per palm per year were found to be optimum for oil palm (Varghese, 1994). Nutrient values and dry matter production of this particular treatment was considered in the present study. Annual dry matter production of waste materials through leaves, male inflorescence, empty fruit bunches (EFB), mesocarp wastes and shell of nut were determined. Nutrient contents in the palm wastes were determined using Kjeltech autoanalyser for N, Spectronic 20 for P and atomic absorption spectrophotometer for K, Ca and Mg. Annual nutrient addition through these components were determined using values of dry matter production and nutrient concentration.

Organic waste materials and by-products obtained were composted using various digestion methods viz., (1) aerobic digestion by frequent mixing, (2) anaerobic digestion without disturbance, (3) microbial digestion using *Pleurotus*, (4) digestion using chemicals and (5) vermicomposting using earthworm, *Eudrillus eugineae*. The C/N ratio and nutrient content of the composted manure were also determined.

RESULTS AND DISCUSSION

The annual dry matter production of a 16 year old oil palm plantation varied with agronomic treatments (Table 1). Annual mean dry matter production of the pruned leaves was 9,457 kg per ha per year which was comparatively lower than the earlier reports (Siew Kee, *et al.*, 1969; Corley, 1971). This was mainly due to the lower rate of leaf production besides its age. However, leaves and pinnae contributed about 70 per cent of the total dry matter through regular harvest and annual prunings and remaining 30 per cent constituted by empty fruit bunches, mesocarp wastes and shell.

Leaves are rich sources of N, P and K (Table 2). The secondary nutrients, calcium and magnesium constituted cations of importance for nutrition especially in high rainfall areas. The total of 120 kg N, 10 Kg P, 140 kg K, Ca and 34 kg Mg could be obtained every year, provided these wastes are properly recycled. As there is a heavy and continuous demand for all these nutrients by oil palm, the organic sources could play a vital role in IPNM.

Table 1. Quantity of dry matter produced in an oil palm plantation

Waste material	Dry matter produced in kg /palm/year					Production
	No fertilizer and irrigation	Irrigation alone*	Fertilizer alone**	Irrigation and fertilizer	Mean	kg/ ha/year
Pinnae	14.8	20.9	21.5	23.2	20.1	2975
Petiole and Rachis	32.1	45.5	46.7	50.5	43.8	6482
Male inflorescence	1.2	1.2	2.4	1.9	1.7	248
Empty fruit bunches	5.9	7.9	9.1	9.1	8.0	1184
Mesocarp wastes	6.9	9.9	12.6	17.9	11.8	1750
Shell	3.2	5.2	5.9	5.6	5.0	736
Total	64.1	90.6	98.2	108.2	90.4	13375

* 901 /palm/day; ** N:P_2 O_5 K_2O::1200:600:1200 /palm/year

Table 2. Nutrient content of oil palm waste materials and its annual contribution

Waste materials	Nutrient content (per cent)					Nutrient contribution in kg/ha/year				
	N	P	K	Ca	Mg	N	P	K	Ca	Mg
Pinnae	2.53	0.15	0.84	0.63	0.31	75.3	4.5	24.9	18.7	9.2
Petiole and Rachis	0.27	0.03	1.12	0.93	0.25	17.5	1.9	72.6	60.3	16.2
Male inflorescence	2.47	0.51	1.59	0.57	1.05	6.3	1.3	3.9	1.4	2.6
Empty fruit bunches	0.96	0.13	2.58	0.21	0.31	11.4	1.5	30.5	2.4	3.7
Mesocarp wastes	0.39	0.04	0.30	0.03	0.08	6.8	0.7	5.3	0.5	1.4
Shell	0.40	0.04	0.41	0.06	0.14	2.9	0.3	3.0	0.4	1.0
Total	-	-	-	-	-	120.2	10.2	140.2	83.7	34.1

Table 3. Nutrient (per cent) contribution by components of waste materials

Waste materials	N	P	K	Ca	Mg
Pinnae	62.6	44.2	17.8	28.3	27.0
Petiole and Rachis	14.6	18.6	51.8	72.0	47.5
Male inflorescence	5.2	12.7	2.8	1.6	7.6
Empty fruit bunches	9.5	14.7	21.8	3.0	10.9
Mesocarp wastes	5.7	6.8	3.8	0.6	4.1
Shell	2.4	3.0	2.0	0.5	2.9

Table 4. Nutrient content (per cent) of compost produced from oil palm wastes though different digestion methods

Digestion methods	N	P	K	Ca	Mg
Aerobic	1.74	0.22	0.68	0.40	0.49
Anaerobic	1.60	0.29	0.62	0.40	0.41
Chemical	1.93	0.47	0.88	0.60	0.37
Microbial	1.49	0.17	0.17	0.40	0.49
Vermi compost	1.67	0.30	0.99	0.53	0.41
Mean	1.64	0.30	0.58	0.47	0.43

Table 5. Effect of cow dung on C/N ratio and nutrient content (per cent) of vermicompost

Cow dung (%)	C/N	N	P	K
Palm waste+ 10	18.56	1.55	0.27	0.89
Palm waste+ 20	17.65	1.63	0.31	0.94
Palm waste + 30	13.59	1.85	0.31	1.13
Mean	16.80	1.67	0.30	0.99

Of the nutrients supplied by different waste materials, 77, 63, 70, 95 and 75 per cent of N, P, K, Ca and Mg were contributed by leaves and petioles (Table 3). Thus, most of the nutrient could be recycled through proper utilization of the leaves and bunch wastes and its continuous supply offered an opportunity to use it as a perennial source of nutrients in oil palm plantations. It is possible to recycle these waste materials by its direct application in plantations as mulch. However, such direct application is not advisable as it has many disadvantages such as harbouring of pests, risk of fire, favour disease incidence, difficulty in harvest, transport and immobilization of nutrient due to wide C/N ratio. So it is necessary to reduce the C/N ratio of pinnae (25:1), petiole and rachies (90:1) and EFB (50:1) to desirable level. Organic wastes were converted in to fine manure of good handling quality within four months by all the decomposition methods attempted in the present study. The C/N ratio of the manure thus obtained was less than 20:1.

Though the nutrient content of manure obtained by different digestion methods did not vary, vermicomposting technique produced manure of more desirable handling quality, lower C/N ratio and a higher nutrient concentration (Table 5). Addition of cow dung was beneficial in bringing down the C/N ratio and improving the nutritive value within a specified period. On an average the vermicomposting recorded 1.7, 0.3, 1.0, 0.47 and 0.43 per cent of N, P, K, Ca and Mg, respectively. With 80 per cent conversion rate, nutrient contribution through organic manure accounted for 175 kg N, 73 kg P_2O_5, 129 kg K_2O, 70 Kg CaO and 71 kg MgO per ha. Thus organic manure contributed 98, 82 and 73 per cent of N, P and K of the annual requirement, respectively.

Traditional agriculture of yester years depended exclusively on limited organic source for nutrient supply where as the present conventional system depends mostly on inorganic fertilizers that harm both soil and environment. Production of nutrient rich organic manure by vermicomposting within the plantation has revealed the potential to integrate organic and inorganic nutrition for oil palm. The nutrient demands of oil palm can be met through proper recycling of waste materials making it a self supporting nutrient utilization system. However, an optimum combination of organic and inorganic sources are to be arrived at for different agroecological zones to improve nutrient use efficiency of oil palm. As such it is recommended to reorient the nutrient management of oil palm into an integrated system both for ecological and economical benefits. Such a system ensures proper disposal of plantation wastes, healthy environment and a sustainable plantation system.

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