Recycling Waste Materials in Oil Palm Plantations -Mulching in Oil Palm

Introduction

The rapid development of oil palm planting industry in Malaysia has given rise to singularly unique hazards to our environmental quality. Most of these are problems pertaining to water and air pollutions churned out at the factory processing level. However, other aspects of environmental hazards originated directly or indirectly from the present cultural pratices in oil palm plantations should be emphasized. For example, the effects of jungle clearing or replanting activities on the quality of water source and water conservation in the region are yet to be quantified. It has also been claimed that the increased use of nitrogenous fertilizers in the plantations had resulted in a sharp increase of nitrogen oxides in the atmosphere.

Sources of pollution are oil palm waste materials which are discharged conveniently into the immediate surroundings at the expense of other bio-economic communities. These waste materials may include palm oil mill effluent (POME), empty fruit bunches, nut-shell, mesocarp fibre, palm fronds and trunks. They are rich source of organic materials and when these materials are discharged onto land or water-ways, oxygen is depleted in the ecosystems resulting in detrimental effects on the biological well-being of the micro-environments. The waste materials produced from the Malaysian oil palm industry was estimated for 1980 as in the region of 450 metric tons per day, an amount which is nearly equivalent to the sewage produced by her population.

Apart from the organic content, these waste materials are also rich in minerals which are much needed for plant growth and yield. These minerals include the major elements such as N, P, K, Mg and Ca. Trace elements are also found in these materials. However, these elements cannot be readily made available to the plants if they are directly applied. Burning of these materials would retain most of these elements except N and P. Apart from loss of these essential elements, burning is also an undesirable process due to the air pollution it created.

As the oil palm wastes are plant derived materials, their moisture contents are usually in the region of 40-80 percent as compared to 16-24 percent normally found in soils of the tropics. These waste materials are ideal for use as mulching materials for their moisture reserve is at least three times that of common soil types.

The plant waste materials, when applied on the surface soil, would increase the organic and carbon contents of the soil. Decomposition of these materials would build up a richer humus layer, thus improving cation exchange capacity of the soil and better fertilizer utilization. Erosion of surface soil, especially under torrential rains, would be greatly reduced with the presence of compact plant debris. Apart from the improvement of physical and chemical properties of top soils, these materials would also tend to moderate fluctuation in soil temperature through evaporation of their high moisture reserves. Thus, better root development can be expected under such constant physical environment. However, the presence of higher carbon content would increase C/N ratio of the soil, resulting in depletion of nitrogen and possibly phosphorus plus other micro-nutrients for normal plant growth. Therefore, additional application of nitrogen source may be necessary to lower the C/N ratio in the soil.

Mulching Practices

Fibres and Shells

At nursery level, oil palm mesocarp fibres and nut shells are commonly used as mulches on top of polybags. These mulching materials help in the conservation of soil moisture and also the applied fertilizers, which can be lost substantially under present sprinkler irrigation system. Improved seedling growth by mulching nursery oil palm was recorded by Marynen and Poels (1960) and Gunn et. al. (1966). However, the fibres are not so popularly used because of the risk in fungal infection of the seedlings. Shells are also frequently used to surface the nursery floor, especially to cover up those water-logged areas and on estate laterite roads which are prone to erosions.

Empty Bunches

It is now becoming a practice to mulch newly planted oil palm with empty oil palm bunches, especially when the oil-extraction factory is sited on the same estate. Usually two to four concentric rings of fresh empty bunches are applied around the palm immediately after field transplanting. The cost for such application, inclusive of transportation of empty bunches from the factory in the same estate to the field, was estimated in 1978 to be about M$60/- (sixty ringgits) per acre of sixty palms. The amount of empty bunches required for mulching was estimated to be approximately twelve tons per acre. Cost of application could be higher if mulches were obtained from factory sited outside the plantation. Khoo and Chew (1979) reported significant increase in ffb yield of mulched oil palms grown on poor soils in the east coast of Peninsular Malaysia. The yield difference between the best non-mulched and the best mulched palms amounted to approximately 5 tons per acre over the first four years of harvesting *(Figure 1)*. The yield results showed that best yield was found in the mulched palms which had fertilizer application at the end of rainy season. This study confirmed earlier report by Hew and Khoo (1970) that mulching with empty oil palm bunches within the palm circle could increase ffb yield of oil palms.

From a series of seven Chemara experiments conducted during pre World War II and in the 1950s, Chan and Goh (1978) concluded that mulching of DxD oil palm with 20-30 tons of empty bunches had significantly improved yield through better nutrition uptake and vegetative growth. In addition, the supplement of nitrogen to bunch wastes was also shown to be important for better yield response. In another series of six experiments which were conducted mainly on poor soil series in the west coast of peninsular Malaysia, Chan, Watson and Lim (1980) reported positive yield increases in five out of the six experiments, with mean yield response estimated as 7% *(Table 1)*.

Fronds and Inflorescence

Both the male inflorescences and older fronds of oil palms are usually considered as natural mulch for oil palm groves as they felled. However, the amount of male inflorescences taken as mulch is negligible as compared to felled fronds. As in the empty bunches, oil palm feeding roots could also be found under frond piles between palms. The chemitropism and hydrotropism of oil palm root system are usually observed under such conditions. Observations on beneficial effects of frond mulched were also reported. Examples are reduction in soil erosion and water conservation of the soil. However, effects of frond mulch in relation to fertilizer application on yield performance are yet to be quantified by experiments.

Trunks

Oil palm trunks felled for replanting were always considered in the past as potential foci for disease and pest propagation in the new planting areas. This concern is particularly true with basal stem rot disease, **Ganoderma** sp. and attacks by **Orycete rhinoceros** beetles on young palms. Therefore, burning was a recommended practice to clear up the felled trunks of the old stand for replanting purpose. From biological or agronomic point of view, however, burning of felled palms is a very wasteful exercise, Loh (1979) has critically reviewed the current replanting techniques and was disagreeable to the burning away of vast reserves of carbon and nitrogen present in the palm materials and subsequent replenishment of these vital elements in the soil by

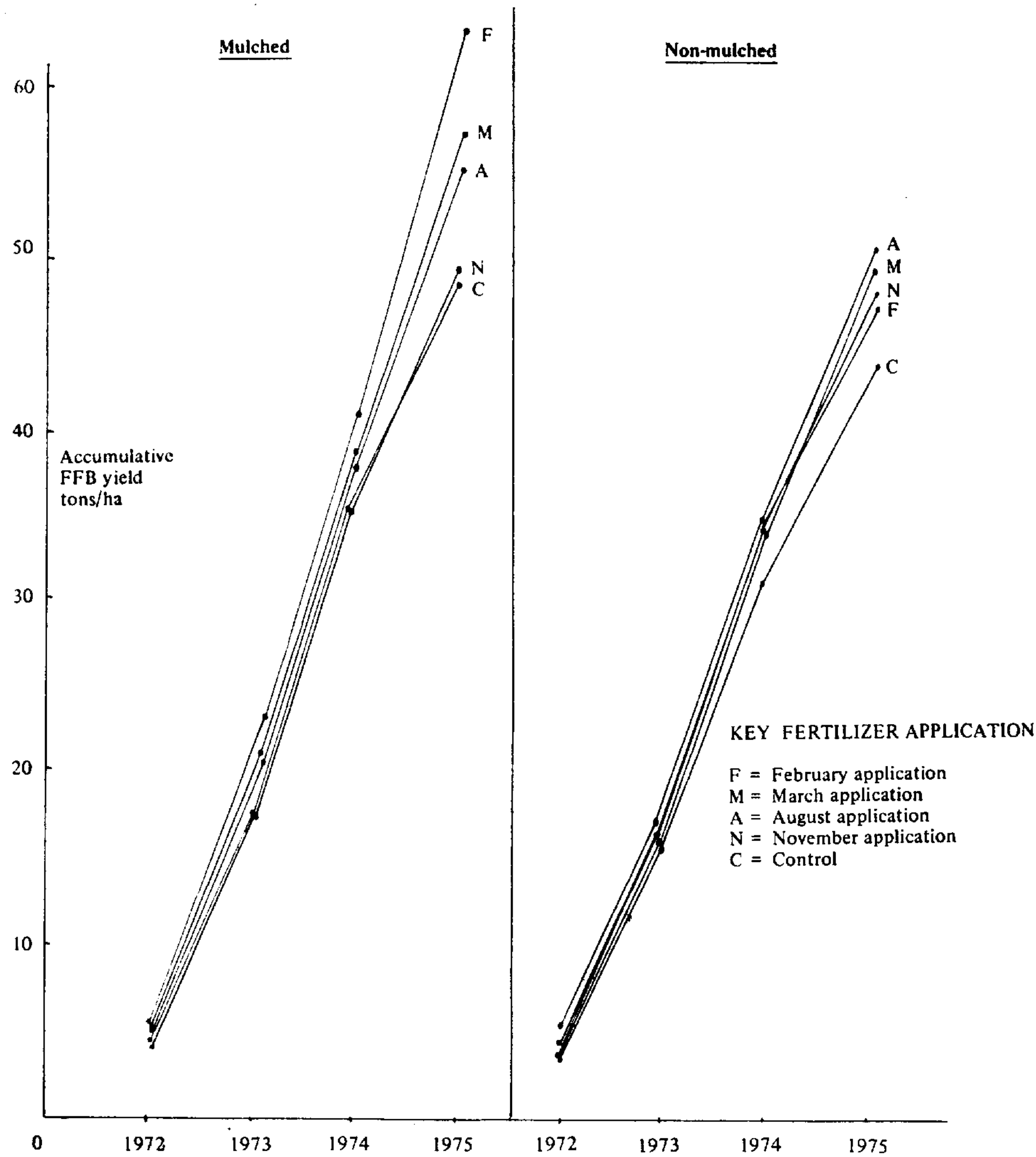

Figure 1: *Effect of mulching on ffb yield of oil palms grown on Durian Soil series in the east coast of Peninsular Malaysia.*
(Khoo and Chew, 1979)

Table 1. **Oil Palm Yield Response To Mulching With Empty Bunches On Poor Soils of West Malaysia**

Expt No	Location	Soil Series	Planting Age	Mulching Rate (ton/acre)	Starting Date	Period of Study (months)	Yield (ton/acre/year) Mulched	Yield (ton/acre/year) Unmulched	% increase
1	Ledang	Malacca	1970	15	Sep 77	24	8.17	7.89	+3.55
2	Bukit Asahan	Malacca	1970	15	Sep 77	24	6.86	7.13	−3.79
3	Bukit Asahan	Malacca	1972	15	Sep 77	24	4.01	3.92	+2.30
4	Tanah Merah	Rengam	1974	15	Nov 77	22	6.18	6.01	+2.83
5*	Sengkang	Prang	1968	15	Mar 79	7	6.59	5.35	+23.18
6*	Glendale	Malacca	1970	15	Apr 79	6	10.35	9.12	+13.49
								Mean	6.93

* Mulching super-imposed in sub-plots on existing irrigation trials.

(adapted from Chan, Watson and Lim, 1980) expensive establishment of leguminous cover crops. By poisoning the old stand of oil palm using sodium arsenite the removal of the palm materials was accelerated (Wood, 1967). Coupled with the use of fast growing leguminous cover e.g. **Mucuna cochin-chinese** to cover the rotting trunk, the incidence of rhinocerous bettle attack on young palms has been reduced. Obviously, research into rapid decomposition of dead palm materials especially the trunks would serve a useful technique in recycling the valuable nutrients in the oil palm plantations.

Effluents

It is estimated that for every 100 tons of fresh fruit bunches (ffb) processed by oil-extraction mill, approximately 70-80 tons of palm oil mill effluent (POME) will be discharged as by-products. Approximately 5% of this voluminous discharge are solid materials and the remaining 95% are water contents. Despite its low solid content, the effluent is rich in organic compounds and minerals. In terms of its oxygen — depleting capacity as determined by the Biochemical Oxygen Demand (BOD) the waste has an average BOD concentration of about 20,000 ppm, i.e. about 100 times stronger than domestic sewage. In order to protect other bio-economic communities, the Environmental Quality Regulations were enforced in mid July 1978 with restrictions on effluent disposal into waterways and land in a number of stages. The final stage of restriction is 50 ppm of BOD requirement for disposal.

Various methods of land application of POME had been considered and studied in detail. Among these methods, it appears that the low application rate (e.g. below 3-4 cm equivalent of rainfall per acre per year) over large areas of oil palm stand would not produce adverse effects on yield. However, the cost for installation of application system over large acreage of plantation could be prohibitory. Further, all methods of direct applications of POME onto estate lands would not be feasible if the Department of Environment has not been persuaded to relax the 50 ppm requirement for effuent disposal. The other common approach was to produce effluent cakes of varying tickness from POME by discharging the skimed effluent into numerous shallow ponds for drying. The dried cakes could be used as fertilizer supplement for the plantations, presumably at a modest rate of application. This method may have some setback in that large non-productive areas for ponding are necessary and drying process can be extremely slow or hampered during the rainy season. Reports have indicated that POME when dried could also be utilized for animal feeds when added with other supplements.

Conclusion

Under increasing pressures from Malaysian Environmental Act to minimise industrial pollution and world inflationary increase in inorganic fertilizer cost, it now appears very timely for Malaysian Oil Palm Planting Industry to review and to reconsider some of their current cultural practices with an effort to maximise the utilization of non-exhaustable resources and to reduce cost of production through recycling of waste materials.

As it is characteristic of oil palm plantations and industries to churn out unequivocal amount of by-products and wastes, it poses a great challenge for research workers and people in planting profession and management to deal with these problems and to provide best solutions for optimal benefits.

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