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Environmental Sustainability in the Palm Oil Industry; Palm Waste as Nutrient Supplement and Effects on Plant Growth Characteristics

Asha Embrandiri [1+], Parveen F Rupani [1], Shlrene Quaik [1], Mahammad H Ibrahim [1] and Rajeev P Singh [2]

[1] Environmental Technology Division, School of Industrial Technology, Universiti Sains Malaysia Penang 11800, Malaysia

[2] Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi, 221005, India

Abstract. The Oil palm industry has turned out to be one of the largest flourishing industries in Malaysia these days. This is owing to the fact that petroleum prices have skyrocketed in the last decade which presented a good opportunity for oil palm as an alternative for fuel. With this increase in demand, environmental management in the palm oil industry is an issue of major concern. In the Palm Oil processing there is a surplus of by-products as utilization rate of these byproducts is low especially for Palm Oil Mill Effluent, Empty fruit Bunch and Decanter cake (DC). This paper takes a brief look at the various uses of these wastes with emphasis on our work on decanter cake. Decanter cake (unamended soil i. e. control, 10, 20 and 30 % w/w DC) was used as an amendment to soil for the growth of vegetables (lady's finger, brinjal and tomato). Effects on seed germination and seedling growth, morphological characteristics and growth pattern among the three plants were studied and results showed that10% DC amendment in all three plants had similar germination pattern (70%) whereas germination in 30%DC amendment was very low for tomato and lady's finger and high for brinjal seedlings. There was significant difference between the shoot lengths in the control of lady's finger as compared to the other treatments (10-30%) unlike the root lengths which showed no significant differences across the 3 plants.

Keywords: Nutrient supplement, Sustainability, Decan ter cake Palm oil mill wastes, Dosage

1. Introduction

In the recent past, palm oil has been converted into bio-diesel as a fuel substitute. It is used in the production of cosmetics, engine lubricants and in the pharmaceutical industry as well besides its most widespread use in the food industry. For this reason, Oil palm has become one of the most sought after crop in the tropics today. Oil palm plantation has increased from 2.03 million hectares to 4.49 million hectares from 1990 to 2009, an increase of 121.2%, in Malaysia [1]. With this, comes the production of large amounts of by-products usually referred to as Palm oil Mill wastes(POMW) such as Palm Oil Mill Effluent (POME), Palm kernel cake (PKC), Decanter Cake, Empty fruit bunches (EFB), Palm Kernel Shell (PKS), and a host of others. These wastes have been productively utilized as a resource in diverse industries but yet to reach its optimum. Large quantities of POMW are still unreasonably discarded. Disposal options carried out these days comprise of land-filling, dumping at sea, soil application and incineration [2]. Vermi composting; the science of using worms to breakdown the complex organic matter, co-composting and composting have been initiated as cost-effective and faster ways for the management of these wastes owing to their organic composition. The complex organic matter is broken into simpler and stabilized forms which can be used for soil amendments. However, due to the inability to obtain large amounts of worms at a given time, vermin-

+ Corresponding author. Tel.: + (60146278662); fax: + (6046573678).
E-mail address: ashanty66@gmail.com

composting has not yet been given the required consideration. Table1 summarizes the various uses of the POMW, production phase in which they are obtained and on-going research.

Table 1: Forms of waste generated in the palm oil mills, the phase of processing and common use pattern.

No	WASTE RESIDUE	STAGE OF PRODUCTION	USES
1	Fronds, trunk and leaves	These are obtained from the plantations itself. Usually fall off or are cut off.	Used as mulching agent in the plantation which helps in moisture retention. Also used as roofing material and some are processed as furniture.
2	Empty Fruit Bunch(EFB)	This is the residue after the fruits have been stripped for sterilization	Earlier used for generating steam for the mills and ash residues used as fertilizer. A major cause of environmental pollution so done on low key [3]. As raw material for products such as paneling, composites, fine chemicals, pulp and paper as well as compost and bio-fertilizer[4]. Main substrate for the cultivation of *Pleurotus ostreatus* (oyster mushroom) [5]. Most of it is discarded back into the fields as the above uses do not meet up to the production.
3	Palm Press Fibre (PPF)	Is the remains after the fruits have been digested and oil extracted.	Fuel for the mills Used as a substrate for animal feed in addition to soymeal, fishmeal. Used for making fibre boards, coir fibre (export) Polymeric composites for building materials referred to as Agrolumber for products like wall panels, sub-floors, doors and furniture parts. Used as potting material for ornamental plants Currently trials are on-going in utilizing fibre+ POME for vermicompositing.[6]
4	Decanter cake	By product obtained after the digestion and extraction phase.	Used as animal feed Used in combination with inorganic fertilizer to improve soil quality [7]. Currently on going work using dried, powdered form of DC as biofertilizer for vegetable gardening.
5	Palm Kernel Cake (PKC)	Generated during the extraction of kernel oil.	Suitable as feedstock because it has 48% carbohydrate and 19% protein [8].
6	Shells	Obtained from the nut cracking process.	Used mainly for fuel. Converted into activated carbon for water purification purposes.
7	POME	Generated from all cleaning processes in the mill.	Mainly used for Irrigation purposes but due to its acidic nature is quite toxic to flora and hence needs to be treated. Carotenes are extracted from POME by pharmaceutical industries

There has been rekindled awareness in the use of agricultural byproducts as organic fertilizer supplements for farming owing to the high costs of synthetic fertilizers and their harmful effects on the ecosystem. Recent reports on a number of death cases due to use of fertilizers and pesticides has brought about more consciousness. The use of readily obtainable and cheap agro-industrial wastes by farmers in both urban and rural areas ensures the sustainability of production, a more balanced crop nutrition and reduction of environmental impacts. However, the direct application of POMW into agricultural soils has caused damages such as water pollution, odour, rodents and pests, leaching etc. Nevertheless by using the

appropriate dose ratio for certain plants, application on soil surface could be one of the long lasting ways of reducing the large quantities of wastes from the mills. Land application is a form of composting in which the materials are incorporated into the soil and left a few days for natural stabilization processes to take place before the seeds are sown. There is no need of specialized places or containers to prepare these composts as in the case of composting and vermicomposting due to lack of space or land area. Then again all these processes reduce the volume of the wastes by over half and results in rich composted material suitable for plant growth which is easier for land application [9].

2. Methodology

Trials were carried out on lady's finger, egg plant and tomato seeds to see the effects on germination and seedling growth. Seed germination test was performed in unamended soil (control), 10, 20 and 30%w/w DC, respectively using petridish and seed germinated was calculated with respect to control taking 10 seeds in each treatment. The experiment consisted of pots in a completely randomized design of about 25cm in diameter and 15cm depth with replicates. Unamended soil (control), 10, 20 and 30%w/w DC, respectively was mixed thoroughly and equal water regime was maintained in the mixtures, and then left a few days for stabilization and mineralization of the organic matter. After germination, the plants were thinned to 3 per pot and kept in the nursery with identical temperature and humidity conditions throughout the growth period. The Electrical conductivity and pH were measured using the Hach Sension5 conductivity meter and Hach Sension3 pH meter respectively. The Pelkin Elmer CHNS analyst 2010 was used to determine the total C: N ratio. Root and shoot length data was taken from fresh plants and all data obtained was subjected to one way ANOVA and Duncan multiple range test using SPSS 17.

3. Results and Discussion

Physico- chemical properties of decanter cake and soil mixtures shows that the addition of decanter cake to the soil caused a reduction in the pH (7.93 – 6.64) but an increase in Electrical conductivity (table 1). Kaviraj and Sharma [10] described this increase in EC could be due to loss of organic matter and release of phosphate, ammonium, potassium etc.

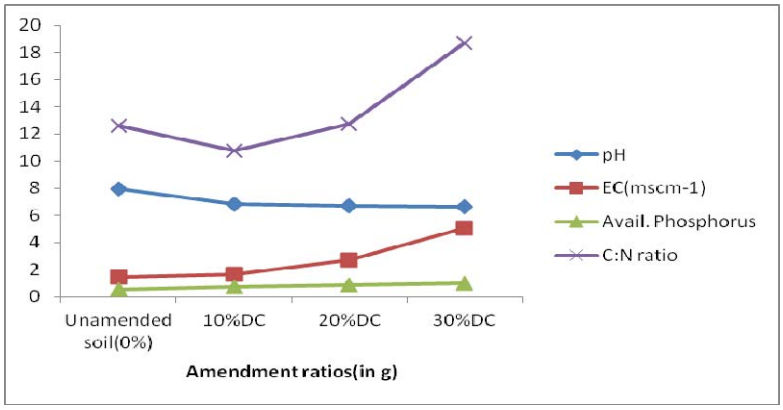

Fig. 1: Figure showing selected physico-chemical properties of soil at the different amendment ratios used.

The C: N ratio was highest at 30%DC (18.72) amendment even though it lowered at 10%DC, CN ratio is the indicator of the maturity of any organic compost. The availability of phosphorus was very low with a slight increase with treatment. The amount of nutrients in the top soil, percolation rate, in addition to the tightness and binding properties of the nutrients determine the rate of leaching [5].

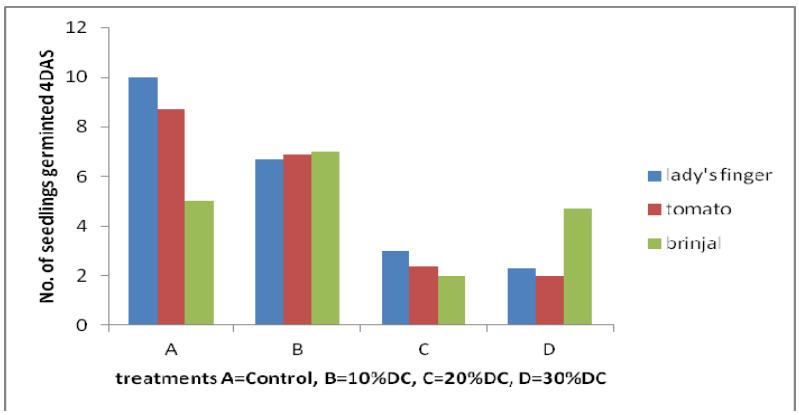

Fig. 2: Figure showing the Number of seedling germinated in 4DAS in the 3 plant species at different mixing ratios

Seedling properties of the 3 plants indicated that each plant had a different trend in their seed germination, root and shoot growth rate. Figure 2 describes the germination number of seeds at 4days after sowing (DAS).We can observe that at 10% amendments, all three plants have similar germination pattern, whereas in lady's finger and tomato seedlings a decline in germination with increasing amendments was recorded. This inhibited germination could be due to the osmotic pressure caused by the rise in dosage of nutrients [11]. Surprisingly, we noted that for brinjal, the germination was higher in 30% than for 20% ratios.

Table 2: The effects of the various decanter cake amendments on shoot and root length growth in the different plants

	Lady's finger		**Tomato**		**Brinjal**	
Treatment	shoot length	root length	shoot length	root length	shoot length	root length
1	30.5 ± 2.78^{b}	11.4 ± 1.44^{a}	30.70 ± 5.69^{b}	8.8 ± 3.62^{a}	4.9 ± 1.44^{a}	5.4 ± 1.70^{a}
2	23.3 ± 3.06^{a}	10.8 ± 0.75^{a}	23.3 ± 4.04^{ab}	7.2 ± 3.54^{a}	21.5 ± 7.55^{b}	12.4 ± 5.43^{a}
3	21.5 ± 5.27^{a}	14.2 ± 11.1^{a}	16.0 ± 7.21^{a}	8.3 ± 3.05^{a}	24.8 ± 3.25^{b}	12.2 ± 2.47^{a}
4	17.5 ± 0.50^{a}	6.1 ± 0.66^{a}	14.8 ± 6.33^{a}	6.7 ± 4.37^{a}	23.7 ± 0.58^{b}	15.3 ± 7.97^{a}

Different letters in each group indicate significant difference at $p<0.05$. A, B, C, D indicates the treatments 0-30%.

There was significant difference between the shoot lengths in the control of lady's finger as compared to the other treatments (10-30%), whereas no significant differences were observed in the root lengths of all treatments in general. In tomato seedlings however, control varied significantly from treatments 3 and 4. For the shoot growth of brinjal seedlings, the means of control varied significantly in contrast with the other treatments (4.9cm).

4. Conclusion and Recommendations

Managing agro-industrial wastes is a major problem globally and for centuries has been a source of health hazards to humans, wildlife and the ecosystem as a whole. Proper planning and utilisation of cost effective methods are some of the ways of ridding the oil mills of the large quantities of solid and liquid wastes produced. Composting and Vermicomposting techniques need some time for the breakdown of the organic matter but however in the long run a large quantity of fine, nutrient enriched product is obtained. This can not only serve in the palm plantations but our studies have shown that it can be applied to other vegetables as a nutrient supplement. One thing to note is that they are dose and plant specific. Thus more research should be funded on the utilisation of these wastes in maintaining the sustainability of our ecosystems rather than the creation of new products. This will reduce the use of chemical fertilizers as palm mill wastes have shown to have high nutrient contents. This in the long run will be a cheap and eco-friendly means to ensuring a sustainable future for agriculture.

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