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THE EFFECT OF OIL PALM EMPTY FRUIT BUNCHES ON SOME SOIL PHYSICAL PROPERTIES AFTER TEN YEARS OF ANNUAL APPLICATION

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INTRODUCTION

The use of oil palm empty fruit bunches (EFB) as a mulching material is gaining attention (Awalludin, 1988; Lim and Chan, 1989). Many researchers have shown that EFB is an excellent surface mulch material because it reduces fertiliser requirement as the trapped nutrients in the EFB are gradually mineralised and released (Vikineswary and Ravoof, 1991). According to Singh *et al.* (1989), EFB can be an alternative source of potash as 1 tonne of EFB is equivalent to 7 kg urea, 2.8 kg rock phosphate, 19.3 kg muriate of potash, and 4.4 kg of kieserite. Vikineswary and Ravoof (1991) further cited that EFB improved the water-holding capacities and aggregation of clayey and sandy soils. Lim and Chan (1989) established that the application of EFB at the immature stage of oil palm increased growth and yield, as well as reduced weeds.

Plate 1: Oil palm fresh fruit bunches

Plate 2: Oil palm empty fruit bunches

Plate 3: Empty fruit bunches as organic mulch

Most of the research carried out on EFB so far was focused on its potential benefits to the yield and growth of oil palm. It is often hoped that EFB would supplement, if not substitute, inorganic fertilisers (Lim and Chan, 1989). There is little information about the effect of EFB on soil physical properties.

Empty fruit bunch is an organic material. It is well documented that organic matter improves soil physical properties by lowering the bulk density, increasing the water-holding capacity, aggregation and aggregate stability, and by lowering the soil strength. However, the effects of organic matter can be complex. It is known to deviate, more often than desired, from its familiar benefits and attributes. Different types of organic matter will affect soil structure and other physical properties differently (Smith and Elliot, 1990).

Consequently, the objective of this study was to determine the changes in some soil physical properties after ten years of annual application of EFB at two different rates: 150 and 300 kg palm^{-1} year^{-1}.

Materials and methods

The trials were conducted at field number ROP (Recovered Oil Palm) 77, Sungai Linau Division, Sepang Estate, Selangor. The soil in the field ROP 77 was of the Bungor series (fine clayey, kaolinitic, isohyperthemic Typic Kandiudult), which had sandy clay texture (58% sand and 37% clay).

Two rates of EFB were examined: 150 and 300 kg palm^{-1} year^{-1}, as well as a control treatment (no EFB or fertiliser application). As there were 136 palms ha^{-1}, EFB rates of 150 and 300 kg palm^{-1} year^{-1} were equivalent to 20.4 and 40.8 tonnes ha^{-1} year^{-1}, respectively. There were four plots for each EFB rate, and for the control; three of these were studied. All plots were arranged in a Completely Randomised Design (CRD). The application of EFB was terminated after ten years of annual application. The study was conducted one year after the application of EFB had ceased; therefore it was mainly on the effect of EFB on soil physical properties one year after the last of ten annual applications.

The physical properties of two soil depths were studied: 0-150 and 150-300 mm. Bulk density was determined by the core ring method (Blake and Hartage, 1990), and the rings were 40 mm in height and 74 mm in diameter. The method described by Kemper and Rosenau (1990) was used to determine aggregate stability and aggregation. Aggregate stability was determined by the wet-sieving method using a nest of sieves: 0.3-, 0.5-, 1.0-, 2.0-, 2.83-, 4.76- and 8.0-mm. Aggregation was expressed as the mean weight diameter (MWD) index. Shear strength was measured using a vane shear tester, where the width of the vane blade was 19 mm and the height was 29 mm. Soil bearing capacity was measured using a soil hardness tester (Yamanaka Type, Kiya Seisakusho Ltd., Japan).

Analysis of variance, based on a 3x2 factorial experiment in CRD, was used to detect significant treatment effects. If treatments were significantly different, Least Significance Difference (LSD) at the 5% level was used to detect differences among treatments.

Table 1. Soil bulk density (Mg m^{-3}) under two rates of EFB in kg palm^{-1} year^{-1}

Depth (mm)	Control	150 kg	300 kg
0-150	1.28a	1.22a	0.95a
150-300	1.48a	1.44a	1.31a

Table 2. Treatment effect on gravimetric water content (g g^{-1}) of the soil.

Depth (mm)	Control	150 kg	300 kg
0-150	0.15a	0.11a	0.19a
150-300	0.11a	0.10a	0.15a

Table 3. Treatment effect on aggregate stability (%).

Depth (mm)	Control	150 kg	300 kg
0-150	73.11a	57.92a	59.64a
150-300	49.55a	43.20a	52.49a

Means followed by the same letter are not significantly different at the 5% level

Table 4. Aggregation or MWD (mm) for the three treatments

Depth (mm)	Control	150 kg	300 kg
0-150	2.71a	1.72b	1.77b
150-300	0.72b	1.84ab	1.72b

Table 5. Soil shear strength (kPa) under the three treatments

Depth (mm)	Control	150 kg	300 kg
0-150	52.6ab	62.2abc	46.1a
150-300	78.7cd	87.9d	74.8bcd

Table 6. Bearing capacity (g mm-2) of the soil under the three treatments

Depth (mm)	Control	150 kg	300 kg
0-150	15.9a	28.0a	20.5a
150-300	35.4ab	61.5bc	35.3a

Means followed by the same letter are not significantly different at the 5% level

Results and discussion

All results showed insignificant effect of EFB on bulk density, water content, aggregation, aggregate stability, shear strength and bearing capacity at the 5% level of significance (Tables 1 to 6). Addition of EFB, even at 300 kg palm^{-1} year^{-1}, did not significantly improve the above soil properties.

The marginal effect of EFB on aggregation is related to its insignificant influence on bulk density and total water content. Aggregation would produce a soil that is very loose, which increases total porosity. A loose soil would in turn have lower bulk density and higher total water content (Brady, 1990). In the same way, the lack of marked differences in aggregation between the EFB treatments and the control would also produce an insignificant result in bulk density and water content, which was found in this study. That the EFB did not significantly affect bulk density, water content and aggregation usually means that soil properties, like shear strength and bearing capacity would also not be appreciably affected. In this study, shear strength and bearing capacity only increased with depth because of the compaction and weight of the overlying soil layers; the EFB treatments had no noticeable effect.

There are two possible reasons to explain the trivial effect of EFB on soil physical properties. Firstly, in a period of one year after termination of the experiment, EFB had decomposed to such an extent that its useful humus constituents were lost and their beneficial effects no longer significant compared to the control plots. Secondly, EFB may not have the necessary substrate quality or chemical composition for the soil microbes to decompose and convert it to useful humus components. It may also fail to have enough humus-forming substrates to bring about a significant change.

The EFB may not be able to produce sufficient amounts of long-chain organic compounds that could bind and stabilize large-sized particles. This is in view of the fact that the soil studied had a large proportion of sand particles (almost 60% sand). High proportions of sand relative to finer materials like silt and clay would stretch the ability of cementing agents from EFB to cover as much distance as possible between particles. This would not be a problem if there were large amounts of these cementing agents that are long enough to spread themselves from one large sand particle to another, and create strong bonds. Decomposition of EFB may have degraded these long-chain compounds so that their amount in the soil was no longer enough to stabilize large aggregates.

The insignificant results in this study suggest that a one-year period after terminating EFB applications was not optimal. The effect of EFB could have been significant in improving soil physical properties, especially just after application. However, decomposition of the humus over the period of one year resulted in losses, and the effect became insignificant in comparison to the control.

The efficiency of EFB is also dependent on the ability of the soil microorganisms to convert or decompose this substrate into useful humus components in sufficient amounts. Therefore, its own substrate quality and chemical composition for soil microbial decomposition are important. The amount of EFB applied would also determine its capability to improve soil properties.

Recommendations

The insignificant results in this study indicated that: 1) higher application rates (more than 300 kg palm^{-1}) are needed if the application period of one year is to be maintained, and 2) a shorter period like six months between applications is required for current application rates (150 and 300 kg palm^{-1}) to be maintained. Composting EFB prior to application could be a feasible compromise.

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