PROCEEDINGS

SOILS 2009

SOIL HEALTH: PRESERVING RESOURCES FOR SUSTAINABLE AGRICULTURE

13 - 15 April, 2009

Primula Beach Resort Kuala Terengganu,
Terengganu Darul Iman

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PHYSICAL CHANGES TO OIL PALM EMPTY FRUIT BUNCHES (EFB) AND EFB MAT (ECOMAT) DURING THEIR DECOMPOSTION IN THE FIELD

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ABSTRACT

The main objective of this study was to determine the physical changes to oil palm empty fruit bunches (EFB) and EFB mat (Ecomat), used as soil mulching materials, during their decomposition in the field. The field experiment was conducted at an estate with nine-year-old oil palm trees and with a hill slope of 6°. The experimental design was a Randomized Complete Block with two treatments (EFB and Ecomat) and three replications. For each replication, EFB was applied as a single layer on the soil surface at a rate of 1000 kg palm^{-1}. Ecomat was applied as a single layer of four carpet pieces, arranged side-by-side and without gaps between the pieces. Each piece of Ecomat carpet had an area of 1 m^2 and an average thickness of 20 mm. Data was collected every two months interval for six months. Physical properties of EFB and Ecomat measured were bulk density, water content, water retention, and saturated hydraulic conductivity. Additionally, soil water content up to 750 mm depth was measured daily. The mean thickness of EFB and Ecomat at the start of the experiment were about 120 and 20 mm, respectively. For EFB, its thickness reduced at a rate of 15.0 mm month^{-1}, whereas for Ecomat, at a slower rate of 2.4 mm month^{-1}. It was estimated using linear regression equations that both EFB and Ecomat would fully decompose in slightly over 9 months. Results also showed that as compared to Ecomat, EFB had a lower bulk density, higher saturated hydraulic conductivity and higher water content. EFB also held its water more strongly than Ecomat. All these properties helped the soil treated with EFB to have more water than the soil treated with Ecomat. Ecomat was, on average, two times more compact than EFB (0.24 Mg m^{-3} for Ecomat against 0.11 Mg m^{-3} for EFB). Bulk density for both materials, however, would not significantly change over time. Nevertheless, saturated hydraulic conductivity (K) for EFB was, on average, two times higher than for Ecomat, and the K for both mulching materials would decrease by over two times over time. EFB also contained more water (by 26.6%) and held the water more strongly than Ecomat. Lastly, the soil under EFB mulch had, on average, 16% more water than the soil under Ecomat mulch.

INTRODUCTION

There has been many research done on the effects of empty fruit bunches (EFB) on the soil chemical and physical properties. However, little has been studied on the physical changes of EFB itself over prolonged periods. One well-known disadvantage of EFB is it is bulky and heavy. Consequently, one recent method is to compress the EFB into a mat or carpet known as Ecomat. Being lighter and less bulky, transportation and handling of Ecomat is expected to be easier than EFB. However, there has been little studied on Ecomat. Therefore, the main objective of this study was to determine the physical changes to EFB and Ecomat, used as soil mulching materials, during their decomposition in the field.

MATERIALS AND METHODS

The field experiment was conducted in an oil palm estate located at Balau Estate (2.9325 °N and 101.8822 °E), Semenyih, Selangor. The estate had nine-year-old palms (*Elaeis guineensis*), and the soil was Rengam series (*Typic Paleudult*). The oil palm trees were planted with a 8-by-8 m spacing on a hill slope of 6°. The total area of the experiment was 2240 m^2. The experimental design was a Randomized Complete Block (RCB) with two treatments (EFB and Ecomat) and three replications. For each replication, EFB was applied as a single layer on the soil surface at a rate of 1000 kg $palm^{-1}$. The mean weight of EFB was 3.5 kg per bunch and the mean thickness was 130 mm. For the Ecomat treatment, it was applied as a single layer of four pieces of Ecomat carpet, arranged side-by-side and without gaps between the pieces. Each piece of Ecomat carpet had an area of 1 m^2 and an average weight and thickness of 3.3 kg and 20 mm, respectively. The experiment was conducted for six months, starting from February to September 2008. The EFB and Ecomat samples were collected every two months. Two samples were collected randomly from every plot.

Four physical parameters of EFB and Ecomat were measured. They were bulk density (core ring method by Blake and Hartge, 1986); gravimetric water content (Gardner, 1973); water retention (ceramic plate method by Richards, 1947); and saturated hydraulic conductivity (adapted method from Klute and Dirksen, 1986). In addition, volumetric soil water content up to 750 mm depth was measured daily using a soil moisture probe AquaPro-Sensor (Aquatic Sensors, Nevada). Statistical analyses was done using SPSS version 14 (SPSS Inc., Chicago).

RESULTS AND DISCUSSION

Figure 1 shows the decreasing rate of thickness for both mulching materials left in the field. The mean thickness of EFB and Ecomat at the start of the experiment were about 130 and 20 mm, respectively. For EFB, its thickness reduced at a rate of 15.0 mm $month^{-1}$, whereas for Ecomat, a slower rate of 2.4 mm $month^{-1}$. Using the fitted linear regression curves, it was estimated that both mulching materials would be fully decomposed (*i.e.*, reduced to zero thickness) in slightly over 9 months. Figure 2 shows that Ecomat was, on average, two times more compact than EFB. For example, at application date (*i.e.*, start of experiment), the bulk density of Ecomat was 0.24 Mg m^{-3} as compared to 0.11 Mg m^{-3} for EFB. It was expected that bulk density for both mulching materials to increase with time because they would decompose into increasingly finer materials and, in turn, increasingly reduce the total pore size and increase compaction. Although Figure 2 shows that the bulk density for both mulching materials did generally increase with time, ANOVA revealed that only the sole treatment factor had a significant effect on bulk density at the 5% level of significance. The sole time factor and the Interaction between

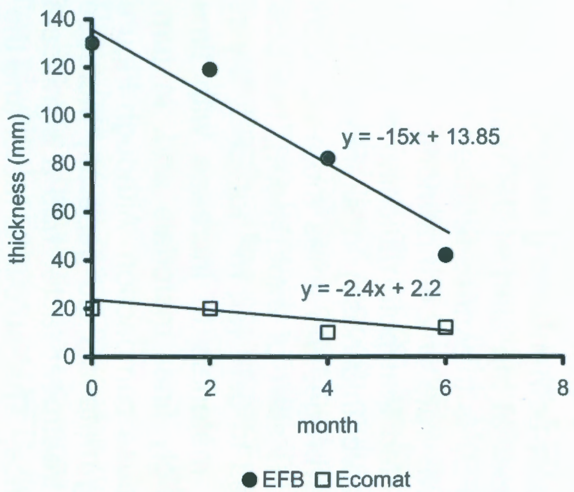

Figure 1. Thickness of EFB and Ecomat

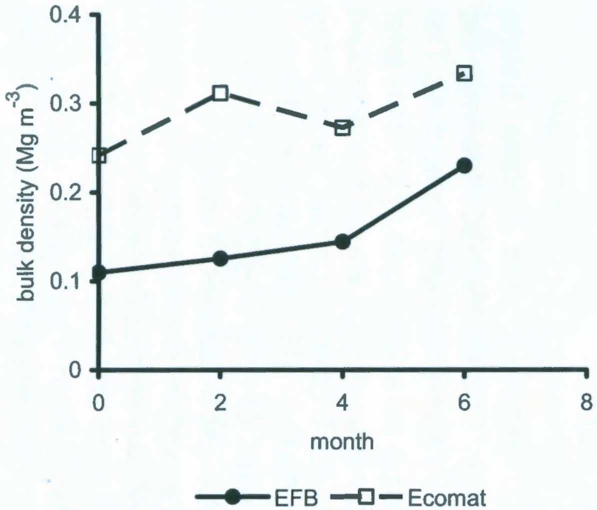

Figure 2. Bulk density of EFB and Ecomat

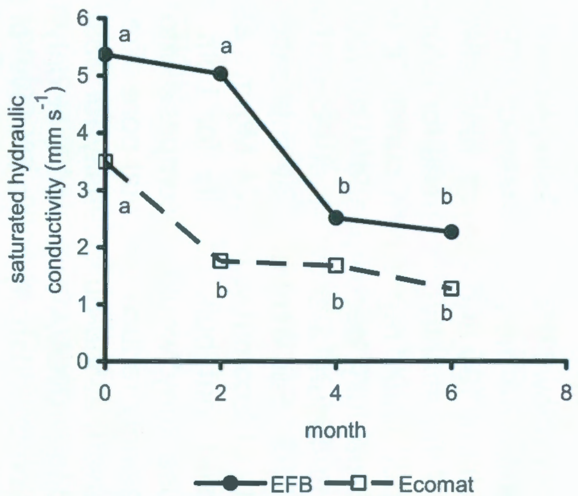

Figure 3. Saturated hydraulic conductivity of EFB and Ecomat

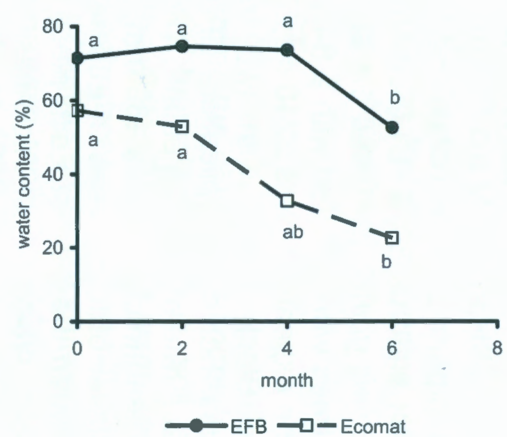

Figure 4. Gravimetric water content of EFB and Ecomat at the time of sampling

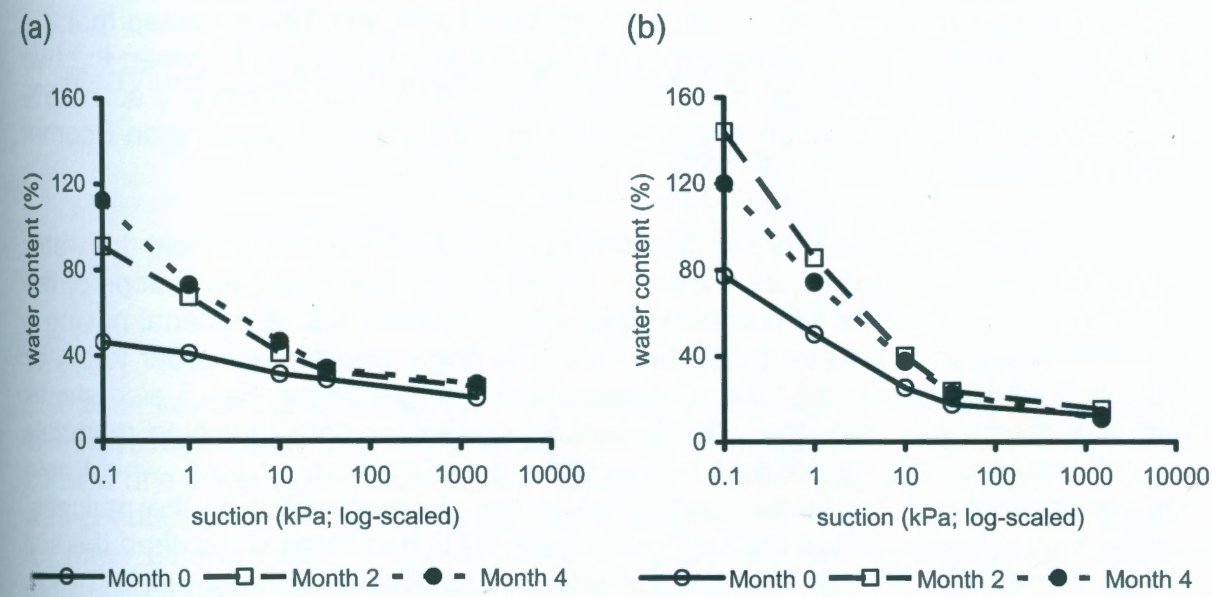

Figure 5. Volumetric water retention curve of: a) EFB, and b) Ecomat

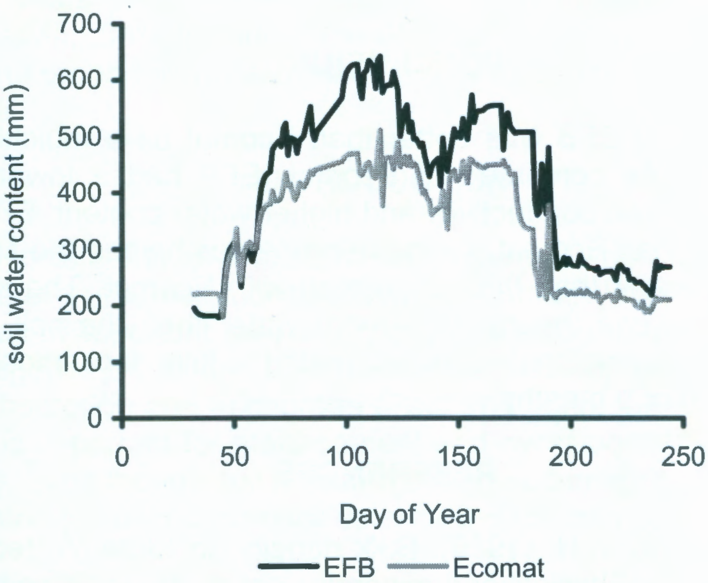

Figure 6. Total daily water content in the soil (up to 750 mm depth) under EFB and Ecomat mulch

treatment and time factors were not significant at the 5% level. The non-significant effect of the time factor could be due to high variability in the measurements of bulk density in this study. Nevertheless, for saturated hydraulic conductivity (K), ANOVA revealed that the sole effects of time and treatment factors (but not the interaction between the two factors) on K were significant at the 5% level. Figure 3 shows that on average, K for EFB and Ecomat were 3.8 and 2.0 mm s^{-1}, respectively. This meant that EFB would conduct water into the soil nearly two times faster than Ecomat, on average. For both mulching materials, there was nearly a two times reduction in their K over time. For EFB, its K would decrease sharply two months after application (reducing from 5.0 mm s^{-1} in the second month to 2.5 mm s^{-1} in the fourth month), whereas for Ecomat, its K would reduce sharply immediately after application (reducing from 3.5 mm s^{-1} at the start of application to 1.8 mm s^{-1} two months later). Like for K, ANOVA revealed that the sole effects of time and treatment factors (but not the interaction between the two factors) on the water content of the mulching materials were significant at the 5% level. Figure 4 shows that, on average, EFB had 26.6% more water than Ecomat at any one time.

Not only would EFB hold *more water* than Ecomat, EFB would also hold the water *more strongly* than Ecomat, as shown in Figure 5. The mean negative slope of the water retention curve for EFB was 0.13 and for Ecomat 0.23. A material having a smaller slope denotes water being held more strongly (therefore, harder to dry or more difficult to lose water) than a material with a larger slope. Fig. 5 also shows that with increasing time, the water retention slopes for both mulching materials would increase. This meant that both mulching materials, over time, would hold their water increasingly less strongly due to the decomposition of the mulches. Lastly, Figure 6 shows that the soil treated with EFB had more water than the soil with Ecomat treatment. On average, the total daily soil water content (up to 0.75 m depth) under EFB and Ecomat mulches were 382 and 322 mm. In other words, the soil water content under EFB had, on average, nearly 16% more water than the soil under Ecomat.

CONCLUSIONS

This study showed that EFB was better than Ecomat as a mulching material to conserve soil water. As compared to Ecomat, EFB had a lower bulk density, higher saturated hydraulic conductivity and higher water content. EFB also held its water more strongly than Ecomat. All these properties helped the soil treated with EFB to have more water than the soil treated with Ecomat. The soil under EFB mulches had, on average, nearly 16% more water than the soil under Ecomat mulches. Both mulching materials were estimated to fully decompose in the field in nearly the same time of 9 months.

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