UNIVERSITI PUTRA MALAYSIA

EFFECTS OF MACHINERY COMPACTION OF BERNAM SERIES SOIL (TYPIC ENDOAQUEPTS) ON SOIL PROPERTIES AND OIL PALM PERFORMANCE

ZURAIDAH YAHYA

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Specially Dedicated to

My beloved husband,
Dr Mohd Haniff Harun

and

my dear children,
Muhammad Syukri
Muhammad Syazwan
Nurin Syazwina

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

EFFECTS OF MACHINERY COMPACTION OF BERNAM SERIES SOIL (TYPIC ENDOAQUEPTS) ON SOIL PROPERTIES AND OIL PALM PERFORMANCE

By

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Mechanization was introduced to the oil palm plantations to overcome labor shortage and to improve production efficiency. The impact of soil compaction from the mechanization contributes to gradual alteration of soil physical properties. The information on severity and extent of soil degradation due to mechanization are still lacking. Hence, this study was carried out to determine the extent of soil degradation resulting from mechanization activities and its subsequent influence on oil palm performance.

The study was carried out at Melentang Estate in Bagan Datuk, Perak, Malaysia. The site was a flat coastal terrain of clayey Bernam Series soil (Typic Endoaquepts). It was planted in 1996 with GH300 DxP materials at planting density of 148 palms per hectare and the trial was started in 2002. The treatments were combination of three trailer weights (0, 2 and 4

tonnes) and three transportation frequencies (1, 2 and 3 rounds monthly). Soil physical analyses and vegetative measurements were done twice a year. Yield was recorded every 10 to 12 days and root samplings were taken at the end of the trial.

After six years of compaction treatments, the soil bulk density and total porosity were significantly increased and reduced by 30% and 15% respectively. Compaction was further indicated by a significant reduction of macropores by 10% and increment of mesopores and micropores by 10% and 3% respectively. This resulted in increased available water of the compacted soil by 19%. However, the soil hydraulic conductivity and infiltration rate were significantly reduced by 51% and 31% respectively. Most of the changes in the soil physical properties were found only within the first 0 to 10 cm depth of the harvesting path.

Although soil compaction was expected to reduce the oil palm yield, the results show otherwise. The fresh fruit bunch (FFB) yield, bunch number and bunch weight increased by 11%, 14% and 2% respectively in the compacted plots as compared to control. However, the oil palm standing biomass in control plots was significantly higher by about 11%. Although there was no significant difference in trunk height, the palm in the compacted plots exhibited a significant reduction in trunk diameter by 9%, trunk dry weight by 8% and frond dry weight by 6% as compared to the control. Total leaf area was not affected as reflected in the optimum leaf area index (*LAI*) value. A greater root biomass was observed in the control,

while the treated plots showed a decreasing trend in root biomass with increasing trailer weight. The reduction in total root biomass in the compacted plots was compensated by higher tertiary and quaternary roots biomass. This resulted in a significant increase in root surface area for better water and nutrient uptake as compared to the control.

The results indicated that six years of compaction treatments had affected the soil physical properties of this Bernam series soil, but it was non-limiting to palm growth, since a positive relationship was found between these treatments and oil palm yield.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

KESAN PEMAMPATAN TANAH OLEH PENGGUNAAN JENTERA DI TANAH SIRI BERNAM (TYPIC ENDOAQUEPTS) KEATAS CIRI TANAH DAN PRESTASI SAWIT

Oleh

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Mekanisasi telah diperkenalkan di ladang sawit untuk mengatasi masalah kekurangan tenaga buruh dan untuk meningkatkan produktiviti. Kesan kemampatan tanah oleh mekanisasi menyebabkan perubahan kepada ciri fizik tanah. Maklumat mengenai tahap degradasi tanah disebabkan oleh mekanisasi masih kekurangan. Dengan itu, kajian ini telah dijalankan untuk mengetahui tahap degradasi tanah disebabkan oleh aktiviti mekanisasi dan pengaruhnya terhadap pertumbuhan sawit.

Kajian ini telah dijalankan di Estet Melentang, Bagan Datuk, Perak, Malaysia. Kawasan kajian ini adalah tanah liat rata Siri Bernam (Typic Endoaquepts). Ianya mula ditanam dengan bahan tanaman GH300 DxP dengan kepadatan 148 pokok per hektar pada 1996 dan kajian telah dimulakan pada 2002. Rawatan pemampatan tanah adalah terdiri dari 3 berat timbangan treler (0, 2 dan 4 tan) dan 3 pusingan perjalanan (1, 2

dan 3 pusingan sebulan). Analisis ciri fizik tanah dan pengukuran tampang dijalankan 2 kali setahun. Hasil sawit direkodkan setiap 10-12 hari dan sampel akar telah diambil pada akhir kajian.

Setelah 6 tahun kajian dijalankan, didapati kepadatan tanah meningkat sebanyak 30% dan keronggaan tanah berkurangan sebanyak 15%. Kemampatan tanah telah ditunjukkan selanjutnya oleh 10% pengurangan rongga-makro, dan peningkatan rongga-meso dan rongga-mikro masing-masing sebanyak 10% dan 3%. Ini telah menyebabkan muatan air tersedia meningkat sebanyak 19%. Walau bagaimanapun, konduktiviti hidraulik tanah dan kadar infiltrasi berkurangan masing-masing sebanyak 51% dan 31%. Kebanyakan perubahan ciri fizikal tanah hanya didapati pada lapisan 0-10 cm di lorong tuai.

Walaupun pemampatan tanah dijangka akan menyebabkan hasil sawit menurun, keputusan kajian menunjukkan plot yang dimampatkan menghasilkan peningkatan tandan segar, bilangan tandan dan berat timbangan tandan masing-masing sebanyak 11%, 14% dan 2%. Walau bagaimanapun, tiada perbezaan signifikan pada ketinggian batang sawit di plot yang dimampatkan menunjukkan pengurangan 9% ukuran garipusat, 8% berat kering batang dan 6% berat kering pelepah. Jumlah keluasan daun tidak dipengaruhi oleh rawatan yang dijalankan dengan menunjukkan indek keluasan daun (*LAI*) yang optimum. Plot kawalan menunjukkan jumlah berat akar yang lebih tinggi, tetapi plot yang dimampatkan menunjukkan penurunan jumlah akar dengan peningkatan

berat treler. Pengurangan jumlah akar pada plot yang dimampatkan telah diimbangi dengan peningkatan jumah akar tertiari dan kuartenari. Ini menghasilkan peningkatan signifikan keluasan permukaan akar untuk penyerapan air dan nutrien dengan lebih efisien.

Keputusan kajian menunjukkan 6 tahun rawatan pemampatan telah memberi kesan kepada ciri fizikal tanah Siri Bernam, tetapi perubahan ini tidak membataskan pertumbuhan sawit kerana didapati ada hubungan yang positif antara rawatan pemampatan tanah dengan hasil sawit.

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