Field Trial Evaluation of Specially Formulated Palm Biomass Compost Fertilisers

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ABSTRACT

Empty fruit bunch (EFB) and palm oil mill effluent (POME) co-composting could produce organic fertiliser which is good for conventional straight chemical fertiliser substitution in oil palm plantations. Field trial performance evaluation of specially formulated palm biomass compost fertilisers known as 'Living Organic Fertiliser' and 'Fortified Organic Fertiliser' in various soil types showed that organic fertiliser application had improved the fresh fruit bunch (FFB) yield significantly compared to conventional straight chemical fertiliser application, except for clay-sandy soil.

Keywords: C:N ratio, organic fertiliser, palm biomass composting.

INTRODUCTION

Empty fruit bunches (EFB) have been used for mulching in oil palm plantations to increase soil organic matter content (Hamdan *et al*., 2006). About 260 kg ha^{-1} of nutrients are lost from the field through harvesting of fresh fruit bunches (FFB), as shown in *Table 1*.

Although about 27% of nutrients lost could be restored by the EFB mulching practice, the long degradation period and expensive transportation suggests that co-composting of EFB and palm oil mill effluent (POME) would be a better way to restore nutrients to the field.

Composting is a high-temperature aerobic biological process that accelerates the organic solid waste decomposition and converts it into a stable humus-like organic material known as compost (Bertoldi *et al*., 1983).

The predominant microorganism types present during the composting process are bacteria, fungi and actinomycetes which are commonly found in the mill's surrounding environment. Studies showed that a weight ratio of one part EFB to three parts POME with an initial Carbon Nitrogen (C:N) ratio of about 25 to 40 w/w is optimal to reduce 70% of EFB volume and concentrate nutrients with a stable chemical composition after seven to 22 weeks.

TABLE 1. NUTRIENT NET LOSS DUE TO FRESH FRUIT BUNCH (FFB) HARVESTING AND EMPTY FRUIT BUNCH (EFB) MULCHING

Nutrient	Nutrient loss/ returned (kg ha^{-1})		
	Lost - FFB harvesting	Returned - EFB mulching	Net loss
Nitrogen (N)	88.2	19.6	68.6
Phosphorus (P)	13.2	1.1	12.1
Potassium (K)	111.3	42.7	68.6
Calcium (Ca)	24.3	4.5	19.8
Magnesium (Mg)	23.1	2.7	20.4
Total	260.1	70.6	189.5

C:N ratio determines compost quality. EFB is a high carbon source whereas POME is a high nitrogen source, as shown in *Table 2*. The finished compost with a C:N ratio of less than 20 can be considered to have reached maturity stage.

The objective of the study is to carry out field trial performance evaluation using specially formulated palm biomass compost fertilisers known as 'Living Organic Fertiliser' and 'Fortified Organic Fertiliser' and to compare these with conventional straight chemical fertiliser.

TABLE 2. CARBON AND NITROGEN COMPOSITION OF VARIOUS PALM OIL MILL WASTES

Type of waste	Total C (%)	Total N (%)	C/N ratio [w/w]
POME	31.50	4.70	6.70
Decanter slurry	51.70	2.38	21.72
EFB	48.64	0.86	56.15
Pressed fibre (PF)	45.21	0.50	91.45
Oil palm trunk (OPT)	34.14	0.26	176.10

METHODOLOGY

A field trial was conducted at Bukit Berembun Estate in Pahang for five years starting from 2016-2020, as shown in *Figure 1*. The field trial studied the efficacy of Living Organic Fertiliser (during the first year of trial) followed by Eureka Fortified Organic Fertiliser at 5:5:10:2MgO and 12:12:17:2MgO formulations in the subsequent years, and the efficacy was compared to control plots which had been applied with straight chemical fertilisers. Different types of soil in Bukit Berembun Estate had been selected to observe the effect of the organic fertilisers, including laterite, clay and clay-sandy soil.

At the end of 2019, another field trial was conducted with an oil palm estate in Perak (Perak Motor Estate) by comparing the effects of Fortified Organic Fertiliser 5:5:10:2MgO and straight chemical fertiliser on the growth of oil palm trees at their prime ages between 10-11 years old.

Figure 1. Bukit Berembun Estate field trial.

RESULTS AND DISCUSSION

Based on *Figures 2a* and *2b*, Plot 1 and 2 (laterite soil) showed an average increase of 4.91 Mt ha^{-1} yr^{-1} in FFB yield from 2016-2017, before the field was subjected for replanting in 2018.

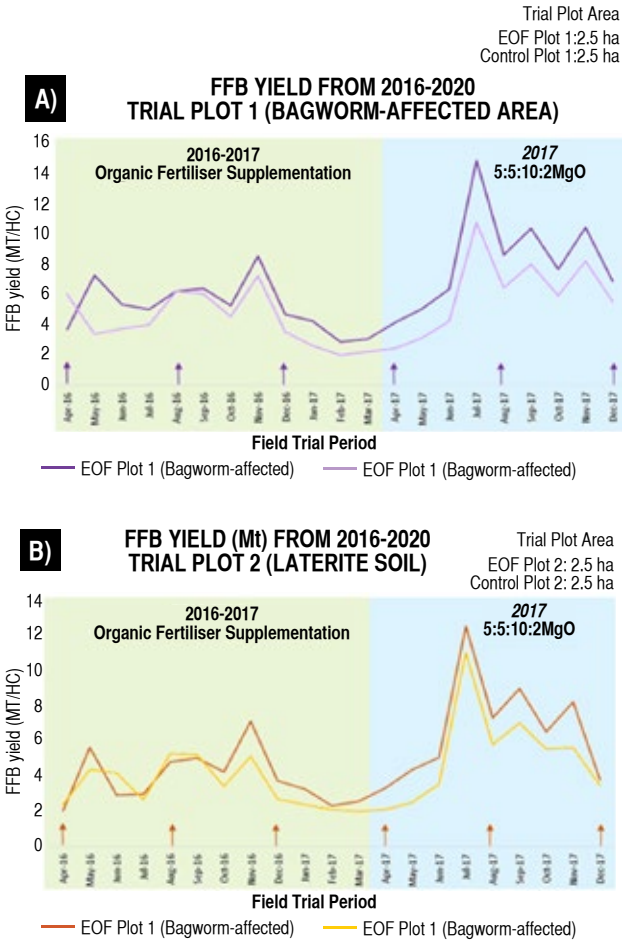

Figure 2. Fresh fruit bunches (FFB) yield of (A) trial Plot 1 and (B) trial Plot 2 treated with Living Organic Fertiliser and Eureka Fortified Organic Fertiliser (EOF) 5:5:10:2MgO as compared to normal fertiliser (control) from 2016-2017.

From *Figure 3*, the results of FFB yield from the organic fertiliser were remarkable as there was an average increase of 7.26 Mt ha^{-1} yr^{-1} in FFB yield in Plot 3 (clay soil) from 2016-2020 as compared to the control plot.

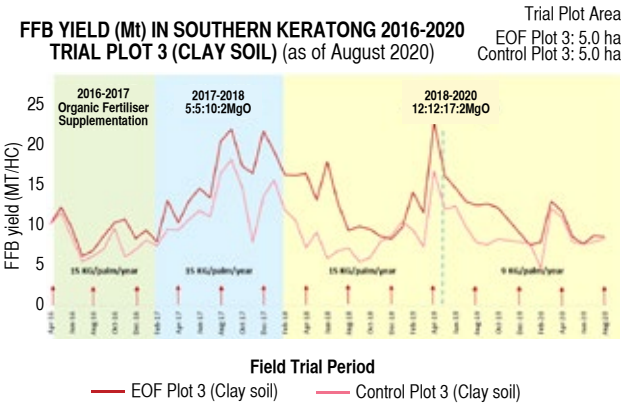

Figure 3. Fresh fruit bunches (FFB) yield of trial Plot 3 treated with Living Organic Fertiliser, 5:5:10:2MgO and 12:12:17:2MgO Eureka Fortified Organic Fertiliser as compared to normal fertiliser (control) from 2016-2020.

Nevertheless, there was no significant change in the FFB yield results as observed from Plot 4 which is made up of clay-sandy soil as shown in *Figure 4*; this trial plot began from 2018 to replace Plot 1 and 2 which had been replanted.

The increase in FFB yield from laterite and clay soil trial plots was mainly due to the increase in the average number of FFB bunches of up to 160 extra bunches from Field P, as shown in *Figure 5*. The average bunch weight recorded from the trial plots had also increased slightly by 1-2 kg/bunch, as shown in *Figure 6*.

Overall, the FFB yield of trial plots in Bukit Berembun treated with Living Organic Fertiliser and Eureka Fortified Organic Fertiliser had improved significantly, with a minimum of 2 Mt ha^{-1} yr^{-1} up to 11 MT ha^{-1} yr^{-1}, as observed in the summary of FFB yield in *Figure 7*. The effects of organic fertiliser were more significant in laterite and clay soils, as compared to clay-sandy soil due to the high porosity in sandy soil which reduces the holding power of organic fertiliser in the soil.

Based on the FFB yield results from the estate as shown in *Table 3*, the total FFB (Mt ha^{-1} yr^{-1}) yield from the control plot was 11.47 Mt from January to December 2020; equivalent to 28.34 Mt ha^{-1} yr^{-1}. In contrast, the total FFB yield from the plot treated with Fortified Organic Fertiliser 5:5:10:2MgO was higher at 14.37 Mt ha^{-1} yr^{-1} during the same period; equivalent to 35.49 Mt ha^{-1} yr^{-1}. This showed a total increase of 2.90 Mt ha^{-1} yr^{-1} in the oil palm FFB yield of the trial plot at Perak Motor estate, which is equivalent to an increase of 7.15 Mt ha^{-1} yr^{-1}. *Figure 8* shows the comparison results.

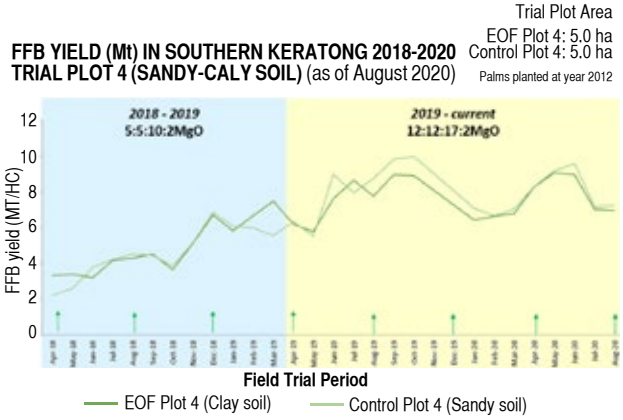

Figure 4. FFB yield of trial Plot 4 treated with Living Organic Fertiliser and Eureka Fortified Organic Fertiliser 5:5:10:2MgO as compared to normal fertiliser (control) from 2018-2020.

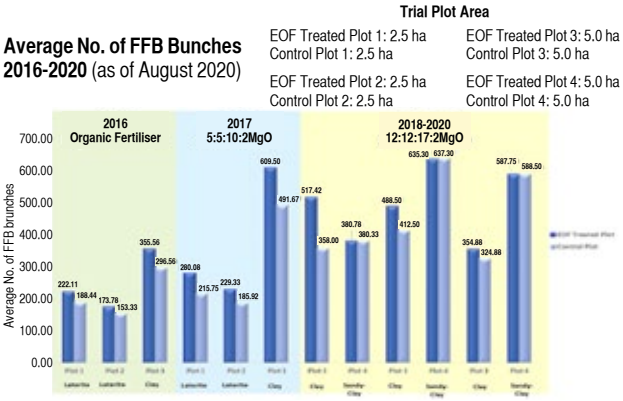

Figure 5. Number of fresh fruit bunches (FFB) bunches (ha^{-1} yr^{-1}) of trial plots treated with Living Organic Fertiliser, 5:5:10:2MgO and 12:12:17:2MgO Eureka Fortified Organic Fertiliser as compared to normal fertiliser (control) from 2016-2020.

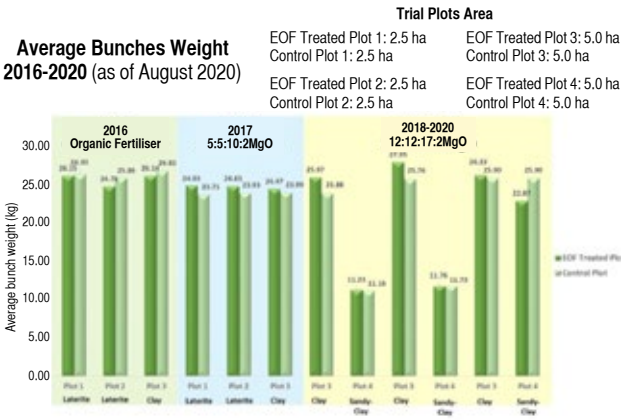

Figure 6. Average bunch weight (ha^{-1} yr^{-1}) of trial plots treated with Living Organic Fertiliser, 5:5:10:2MgO and 12:12:17:2MgO Eureka Fortified Organic Fertiliser as compared to normal fertiliser (control) from 2016-2020.

TABLE 3. FFB YIELD COMPARISON OF EUREKA FORTIFIED ORGANIC FERTILISER *vs.* STRAIGHT CHEMICAL FERTILISER IN 2020

Month	Control Plot (Straight fertiliser)		Trial Plot (Eureka fortified fertiliser)	
	Total yield (Mt)	Yield/acre (Mt)	Total yield (Mt)	Yield/acre (Mt)
January	769.78	0.78	69.02	0.99
February	1 167.12	1.19	95.48	1.36
March	1 071.79	1.09	88.30	1.26
April	874.56	0.89	87.04	1.24
May	954.60	0.97	86.12	1.23
June	1 196.62	1.22	88.19	1.26
July	1 044.02	1.06	93.94	1.34
August	1 073.48	1.09	103.91	1.48
September	1 045.58	1.06	90.28	1.29
October	822.78	0.84	79.07	1.13
November	592.11	0.60	64.53	0.92
December	667.47	0.68	59.79	0.85
Average	**964.77**	**0.96**	**83.81**	**1.20**
Total	**11 279.91**	**11.47**	**1 005.67**	**14.37**
Yield	**28.34 Mt ha^{-1} yr^{-1}**		**35.49 Mt ha^{-1} yr^{-1}**	

Note:

(a)	Straight chemical fertiliser total plot area:	983 acres
	Eureka Fortified Organic Fertiliser trial plot area:	70 acres
(b)	Straight chemical fertiliser application:	7 rounds / year (total 12 kg palm^{-1} yr^{-1})
	Eureka Fortified Organic fertiliser application:	3 rounds / year in Apr, Aug, Dec (total 9 kg palm^{-1} yr^{-1})

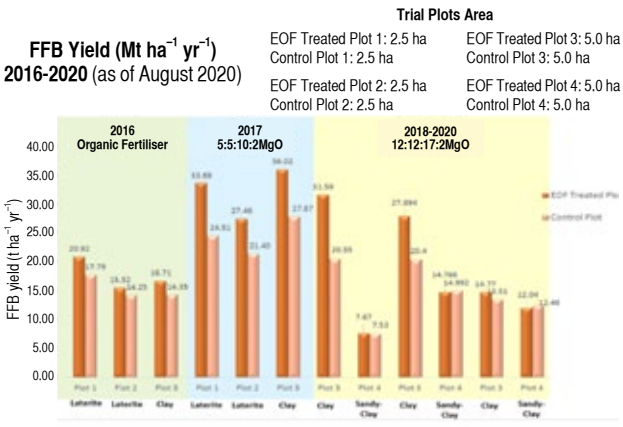

Figure 7. Fresh fruit bunches (FFB) yield (Mt ha^{-1} yr^{-1}) of trial plots treated with Living Organic Fertiliser, 5:5:10:2MgO and 12:12:17:2MgO Eureka Fortified Organic Fertiliser as compared to normal fertiliser (control) from 2016-2020.

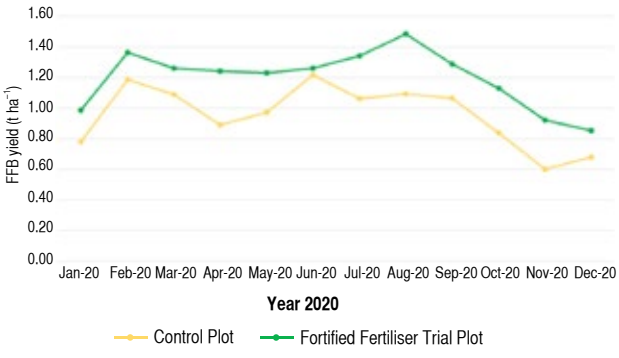

Figure 8. Fresh fruit bunches (FFB) yield (Mt ha^{-1} yr^{-1}) of trial plots at Perak Motor Estate treated with Fortified Organic Fertiliser 5:5:10:2MgO as compared to normal fertiliser (control) starting from 2020.

CONCLUSION

Living Organic Fertiliser and Eureka Fortified Organic Fertiliser with 5:5:10:2MgO and 12:12:17:2MgO formulations have showed excellent performance compared to conventional straight chemical fertiliser application. The organic fertiliser effects were more significant in laterite and clay soils compared to clay-sandy soil where no significant change in the FFB yield was observed. Fortified Organic Fertiliser 5:5:10:2MgO application increased the oil palm FFB yield by 7.15 Mt ha^{-1} yr^{-1} to 35.49 MT ha^{-1} yr^{-1} compared to 28.34 Mt ha^{-1} yr^{-1} achieved by conventional straight chemical fertiliser application at the same trial plot.

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