EFFECT OF PALM OIL MILL EFFLUENT (POME) ON YIELD AND NUTRITIVE VALUES OF NAPIER GRASS

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ABSTRACT. Palm oil mill effluent (POME) is a thick, brownish liquid effluent comprising large amounts of solids and high organic content, convertible into a valuable source of biomass. Based on the nutrient content of POME, this waste has the potential to be utilised as an organic fertiliser. The objectives of this study were to enhance the yield and improve the quality of Taiwan Napier grass especially for crude protein and metabolised energy values using POME in the soil. The standard rate of basal fertiliser was used with applications of 5 metric tonnes POME (55% to 60% dry matter, pH 4.8) per hectare. The grass was cut close to the ground level to get a uniform stand 70 days after planting and then cut at intervals of 60 days for three times. After each harvest, a rated portion of maintenance fertiliser was applied. The Napier plants were cut about 10 cm from the ground and cut plants were weight. Random samples of Napier, representative of each plot were sent for dry matter yield and proximate analysis. The data were analysed using Statistical Analysis System (SAS) followed by Tukey's post-hoc test. A *p*-value of less than 0.05 ($p<0.05$) was considered statistically significant. Results showed that Napier grass with POME treatment gave higher fresh yield, crude protein content and metabolised energy compared to control grass.

Keywords: Napier, POME (palm oil mill effluent), dry matter yield, chemical composition

INTRODUCTION

Agricultural residues is the largest amount of biomass resource in Malaysia and one of the major contributors is the palm oil industry. As Malaysia is the second-largest producer of palm oil in the world, it follows that the palm oil industry is the largest industries in Malaysia with more than 13 million tonnes of crude palm oil being produced yearly, covering 11% of land in Malaysia for its plantations (Ujang *et al.,* 2018). The residues of the palm oil industry include palm oil mill effluents(POME), empty fruit bunches, palm kernel shells and mesocarp fibres. The accumulation of oil palm biomass from the palm oil industry, which is approximately 40 million tonnes per year, has been constantly growing with increasing global demand for crude palm oil. According to Wu *et al*. (2010), statistics published in 2008 showed that 44 million tonnes of POME was generated in Malaysia. POME sludge generated during the production of crude palm oil is abundant and available for use in agriculture. In general, utilisation of sludge in agriculture is considered as one of the best waste management options because it improves the soil's aggregate stability, porosity and water infiltration rate, and supplies organic matter and major nutrients, such as N and P to the soil (Devagi *et al.,* 2016).

Fresh POME is a thick brownish colloidal mixture of water, oil and fine suspended solids. It has very high biochemical oxygen demand (BOD) which is non-toxic as no chemicals are added during the extraction process (Khalid and Wan Mustafa, 1992; Ma et al., 1993). It also acidic with a pH of around 4.5 as it contains organic acids in complex forms that are suitable as a carbon source (Md Din *et al.,* 2006). The raw or partially treated POME has an extremely high content of degradable organic matter. It has been identified as a major source of aquatic pollution, causing depletion of dissolved oxygen when discharged untreated into the water bodies (Setiadi *et al*., 1995). It contains substantial amounts of nitrogen, phosphorus, potassium, magnesium and calcium (Setiadi *et al.,* 1995; Habib *et al.,* 1997; Muhrizal *et al.,* 2006; and Hoon *et al.,* 2001) which are the vital nutrient elements for plant growth.

Wu *et al.* (2009) reported that biologically treated POME has been widely used in the oil palm plantations for irrigation purposes and can be employed as a liquid fertiliser. High content of aluminium in POME as compared to chicken manure and composted sawdust was reported by Muhrizal (2006). The potential for using POME as a cheap organic fertiliser offers an alternative to the excessive application of chemical fertilisers (Wu *et al.*, 2009). The use of POME has been shown to improve soil productivity and increase the yield of crops as well as contribute to better root health by improving the soil structure (Chan *et al.,* 1980. The application of fermented POME to soil can increase the growth and yield of maize (*Zea mays*. L) (Chris *et al*., 2010).

Napier or elephant grass (*Pennisetum purpureum*) is widely used by livestock farmers in Malaysia due to its high production and quality, vegetative material readiness, adaptability to soil and easiness to grow and manage. Napier was first introduced to Malaysia in the 1920s and several cultivars were introduced since the 1950s. Napier grass is the most popular fodder used in dairy and feedlot production (Halim *et al.,* 2013). Napier grass is fast-growing and has a high annual productivity that depends on climatic and soil conditions (Rusdy, 2016). Napier has been the promising and high yield grass, giving dry matter yield that surpasses most other tropical grasses, like Guinea grass (*Panicum maximum*) and Rhodes grass (*Chloris gayana*), and higher nutritive value compared to *Brachiaria* sp. and *Panicum* sp. (Gomez *et al.,* 2011). Napier grass can produce more dry matter per unit area than any other crop. The tender young leaves and stems are highly palatable to livestock (Burton, 1993). Yields ranged from 20 to 80 tonnes/DM/ha/year under high fertiliser input (Skerman and Riveros, 1990). On farms, dry matter yields of Napier grass from different regions average about 16 tonnes/ha/year (Wouters, 1987). Napier Taiwan, which is widely cultivated by livestock farmers, can produce 4.41 tonnes dry matter/ha/cut at 42-days-old and reach up 40 tonnes dry matter/ha/year, when applied with maintenance fertiliser of 150 kg nitrogen, 60 kg phosphorus and 100 kg potassium per hectare per year (Haryani *et al.*, 2018). The application of POME as fertiliser gave the highest yield of Napier grass compared to other conventional fertilisers such as NPK (12% nitrogen), urea (46% nitrogen) and fresh goat dung (Agamuthu *et al.,* 1994).

The objectives of this study were to enhance the yield and improve the quality of Taiwan Napier grass, especially its crude protein and metabolised energy values by using POME in the soil.

MATERIALS AND METHODS

Treatments

Six forage plots (three forage plots on POME treatment and three forage plots on control treatment) were established. All forage plots were 8 m by 3 m and were separated by a 1 m alley. Taiwan Napier Grass were planted in rows spaced 0.6 m apart (Figure 1). 2.5 tonnes per hectare of ground magnesium limestone was added to maintain proper soil pH and adequate magnesium level. Soil pH of 6.0 is adequate for Napier production. Basal fertiliser added per hectare were 60 kg of nitrogen, 30 kg of phosphorus and 30 kg of potassium. 5 metric tonnes per hectare of POME (55% to 60% dry matter, pH 4.8) were used as treatment for the three forage plots (Figure 2). The POME was collected from Coronation Palm Oil Mill at Kluang, Johor. The grasses were cut close to ground level to get a uniform stand 70 days after planting and then cut for harvesting at intervals of 60 days for 3 times. After each harvest, maintenance fertiliser applied per hectare were 150 kg nitrogen, 60 kg phosphorus and 100 kg potassium. The Napier plants were cut about 10 cm from the ground and cuttings were weighed. Random samples of Napier, representative of each plot, were calculated for dry matter yield and its composition determined by proximate analysis (crude protein, metabolised energy, dry matter and crude fibre).

Dry matter yield

The grass was harvested by cutting a whole plot following each treatment. The fresh samples harvested from each treatment were weighed. The grass yield obtained from random samples of Napier, representative of treatment on each plot, were pre-dried in a forced-air drying oven set at 60 °C overnight then ground to pass 1-mm sieves. It was then forced-air dried in an oven at 103 ± 2 °C for over 4 hours (Close *et al.,* 1986) to determine the dry matter and to calculate dry matter per hectare.

Chemical Composition

The ground samples were used to determine chemical composition of the Napier grass. Crude protein (CP) content (N×6.25) was determined after digestion in sulphuric acid by the Kjeldahl method using *Kjeltec*™ systems (FOSS, Denmark). Crude fibre (CF) was measured after treating with boiling dilute sulphuric acid and boiling sodium hydroxide solution using *Fibertec*™ systems (FOSS, Denmark). Finally, the metabolised energy for ruminant was calculated using Menke equation (Close and Menke, 1986).

Figure 1. Taiwan Napier grass

Figure 2. POME

Statistical Analysis

The data were analysed using the general linear model programme of SAS® 9.3 (SAS Institute, USA). The difference between treatment modes was measured by Tukey's post-hoc test. The level of significance used to determine the differences between treatments is $p<0.05$.

RESULTS AND DISCUSSION

Fresh and Dry Matter Yield

In this study, there were significant differences in the performance of POME treated Napier grass and the control. Napier grass treated with POME gave higher fresh yields of 66.16 tonnes/ha/harvest compared to the control at 52.94 tonnes/ha/harvest as presented in Table 1. For dry matter, yield was 9.59 tonnes/ha/harvest for POME treated Napier and 7.73 tonnes/ha/harvest for the control. The results are similar to studies conducted by Agamuthu (1994) where POME treatment gave the highest yield of Napier grass than other treatments. This could be attributed to the fact that POME contains almost all the major and minor elements required for Napier grass growth (Agamuthu, 1992). In 2003, Oviasogie and Aghimien discovered that the proper use and safe disposal of POME on the land, not only conserves the environment but also improves soil fertility due to the vital nutrient elements for plant growth.

Nutritive Value

The nutritive values of Napier grass treated with POME compared with the control are presented in (Table 2). There were no significant differences observed in dry matter and crude fibre content for POME treated Napier grass versus control. Dry matter for Napier grass with POME treatment and control grass were 14.49% and 14.60%, respectively. Crude fibre for Napier grass with POME treatment was 33.94% and control was 33.88%. The results for crude protein content is presented in Table 2. Crude protein in Napier grass with POME treatment is significantly higher than the control. POME treated grass contains 14.92% crude protein compared to 12.82% of the control.

Table 1. Fresh and dry matter yield of Napier grass by POME treatment.

Parameter	Control	POME
Fresh Yield Production (tonnes/ha/harvest)	52.94[b]	66.16[a]
DM Yield Production (tonnes/ha/harvest)	7.73[b]	9.59[a]

Note: Mean with same superscript letters in same row were not significantly different ($p>0.05$)

Table 2. Nutritive values of Napier grass by POME treatment.

Nutritive Values	Control	POME
Dry Matter (%)	14.60[a]	14.49[a]
Crude Protein (%)	12.82[b]	14.92[a]
Crude Fibre (%)	33.88[a]	33.94[a]
Energy/ME (MJ/kg)	8.51[b]	8.94[a]

Note: Mean values with same superscript letter in the same row were not significantly different ($p>0.05$)

The data of this study are consistent with those reported by Saibaba (2004) where crude protein content was found to be highest in Napier grass fertilised with recommended NPK doses of inorganic fertiliser compared to sole application of basal fertiliser only. Chris *et al.* (2010) also mention that the presence of organic nitrogen, magnesium and phosphorus in POME made it usable as an organic amendment to improve soil fertility. As for the energy or metabolised energy for Napier grass, POME treatment also showed it to be significantly higher than controlled grass, at 8.94 MJ/kg and 8.51 MJ/kg, respectively. Increased metabolised energy may be associated with the increased crude protein content.

CONCLUSION

As a conclusion, the application of POME in Napier cultivation increased the yield (up to 57.6 tonnes dry matter/ ha/year) and gave better nutritive values in livestock feedstuff. This study showed that the use of POME can improve soil productivity and significantly increase the yield of Napier grass. In addition to enhancing the yield and improving the quality of Napier grass, the use of POME as an organic fertiliser is also one of the opportunities for converting palm biomass to valuable products and, at the same time, for solving the disposal problem that can cause environmental destruction.

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