Effect of Application of POME and Recommended Fertilizer on Immature Oil Palm Intercropping with Pineapple, Low Country Wet Zone (WL2a) in Sri Lanka

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ABSTRACT

Oil palm plantations in Sri Lanka have spread over 10,000 hectares in the wet zone of the Island. Immature plantations can be increased with some selected intercrops. Pineapple is one of the high demanded fruit crop and is a suitable candidate for intercrop. Palm oil mill effluent (POME) is a problematic waste to manage by mill operators which is generated during processing of fresh fruit bunch (FFB). The objectives of the study were to evaluate the efficiency of POME, effective land utilization, ground cover efficiency of intercrop and improvement of soil physicochemical properties. A field trial conducted at Thalgaswela estate (WL2a) in Galle district, Sri Lanka from 2019 June to 2020 June. Experiment was designed with Randomized Complete Block Design (RCBD) with seven treatments and three replicates. Fertilizers were applied to the pineapple plots according to the department of Agriculture (DOA) recommendations. Growth parameters were taken at monthly intervals and chlorophyll content were measured. Soil physical parameters were measured at the beginning and at the end of the experiment. Results were statistically analyzed with Minitab software. According to the experimental data, oil palm with cover crop and pineapple along with recommended fertilizer were shown effective land utilization, higher number of leaves per plant, highest leaf length, highest spade meter chlorophyll content, soil has highest moisture content. Treatment seven (T7) shows significantly higher number of fruit forming during the research period. To come to a firm recommendation on POME as an organic amendment and performance of pineapple yield, research should be continued for at least more than two yield cycles.

Keywords: Intercropping, Young oil palm, POME, Sri Lanka, Pineapple.

I. INTRODUCTION

As man grew and developed, farming activities had to be re-organized according to the dictates of the environment and time (Timothy, 2002). Therefore it is possible that the plants are different in terms of planting time, and a crop is planted after the major crop (Mazaheri et al., 2006; Ofori et al., 1987). For example, in an oil palm plantation, the oil palms are major component at the recommended planting spacing of 9 meters in triangular arrangement with a wide space of 7.62 meters existing between the palm rows. This wide inter-row space may then be utilized for growing other crops mostly food crops. The benefits of intercropping with oil palms in the field are adding value to the oil palm when the food crops are harvested and sold, particularly in the early years when oil palm has not started to produce fruit bunches (NIFOR, 2008). Secondly, the planting of the food crops between inter-rows of the oil palm helps field maintenance of the plantations, as the field is kept clean vegetation through weeding of the food crops and finally total maintenance cost is reduced (Trenith, 1976).

Oil palm was introduced to Sri Lanka from Malaysia in late nineteen sixties. In Sri Lanka, Oil palm plantations are mainly distributed in South Western part. One hectare of oil palm produces about 10 - 35 tons of fresh fruit bunches (FFB) per year. Oil palm has economic life is about 20-25 years. The nursery period is 11-15 months and first harvest is done 32-38 months after planting. Plant takes 12-15 years for to reach its highest yield.

POME is a by-product after oil extraction, washing and cleaning processes of the mill. It consists of water soluble components of palm fruits as well as suspended cellulosic materials like palm fiber, fat, grease and oil residues (Agamuthu, 1995). However, Rupani et al. (2010) also maintained that among the wastes that are generated from processing of oil palm fruits, POME is considered the most harmful waste to the environment if release untreated. POME is not the only waste produced from the processing of fresh fruit bunch (FFB). But it is the most expensive and difficult waste to manage by mill operators. This is because large volumes in tonnes are generated at a time. The palm oil industry still considers POME treatment a burden rather than as part of the production process, let alone a (Ma A.N. 1999).

Pineapple is one of the foremost commercial fruit crops grown in Sri Lanka. Pineapple production plays an important role in Sri Lankan economy making export earnings of US $2.1 billion in 2018 and it is the...
largest export fruit crop in Sri Lanka (Department of Census & Statistic, 2018/2019). It had 4,825 hectares under cultivation and farmers cultivate pineapples as cash crop in-between young and mature coconut palms (Coppens et al., 2003; Hepton, 2003; Malezieux et al., 2003).

Only a few studies were conducted to study the effects of pineapple intercrop with oil palms and there were lack of firm recommendations. In immature plantations, land productivity can be increased with some intercrops. Pineapple is highly demandable fruit crop and higher potential to be used as a better intercrop. The major problems faced by the pineapple growers are decreasing income due to high cost of production particularly due to fertilizer, and shortage of suitable land for pineapple cultivation.

Oil Palm is an un-branched monoecious, monocotyledonous tree reaches a height of about 20 to 30 meter. It is planted at a space of 9 x 9 m in a plantation. It occupies only 5-15 % area during the immature phase of the plantation (Suresh et al., 2001). Active root zone of an adult palms under good management practices is mainly concentrated within a radius of 0.5 to 3m laterally from the bole and 10-40 cm depth vertically (Suresh et al., 2003). This situation offers a sufficient scope for effective utilization of horizontal and vertical space for growing intercrops.

Objectives of this research were evaluate the efficiency of using POME as fertilizer for pineapple intercrop, evaluate the effective land utilization for pineapple intercrop, measure the ground cover efficiency and measure the improvement of soil physical and chemical properties, by using POME.

II. MATERIALS AND METHOD

A field trial was conducted at Thalgaswella estate in Galle district, low country wet zone (WL2a) from June, 2019 to June, 2020 to find out effect of application of POME and recommended fertilizer on immature oil palm intercropping with pineapple using Randomized Complete Block Design (RCBD) with seven treatments and three replicates.

Each plot was consisted with four Oil Palm plants. Twenty one plots were cleared and soil samples were taken to check the physical and chemical properties. 20 cm x 20 cm planting holes were prepared for pineapple planting. Poultry manure was applied to each planting hole at the rate of 10 Mt per ha.

02 weeks after application of poultry manure to the field, randomly selected “Murusui” plants with 12 to 14 leaves were planted according to the treatments. Desmodium cover crop naturally established in the field was removed from the plots and others were remained according to the treatments shown in table 1. One month after field establishment fertilizer was applied according to the department of agriculture recommendation.

Treatments and three replicates.

RESULTS AND DISCUSSION

The main objective of intercropping is to effective utilization of space left between two rows of the main crop and increase output per unit land area. Under good management oil palm takes three to four years to utilize entire inter space. Intercropping in a given piece of land can increase the productivity not only from palm oil but also from pineapple. Planting pineapple as an intercrop in the young oil palm plantation is tested in this research.

Table 1: Treatments used in the field

| Treatments   | Oil palm with cover crop with pineapple + 75% recommended fertilizer +25% POME |
|--------------|---------------------------------------------------------------------------------|
| Treatment1 (T1) | Oil palm with cover crop with pineapple + 50% recommended fertilizer +50% POME |
| Treatment2 (T2) | Oil palm with cover crop with pineapple +100% POME                               |
| Treatment3 (T3) | Oil palm without cover crop with pineapple + 75% recommended fertilizer +25% POME |
| Treatment4 (T4) | Oil palm without cover crop with pineapple + 50% recommended fertilizer +50% POME |
| Treatment5 (T5) | Oil palm without cover crop with pineapple +100% POME                             |
| Treatment6 (T6) | Oil palm with cover crop with pineapple + recommended fertilizer (Controller)  |
| Treatment7 (T7) | Oil palm with cover crop with pineapple + recommended fertilizer (Controller)  |

The soil samples were collected; before the establishment of trial and at the end of the experiment. The samples were collected according to nonsystematic random sampling method using soil auger.

Soil samples were sieved using 2 mm sieves to remove organic debris, gravel and later powdered using an agate pestle and mortar. All the soil samples were analyzed for colour, moisture content, organic matter content and pH. Soil colour was identified using standard Mansel soil colour chart. Soil moisture content was determined by the oven-dry method (105°C for 24 h) while soil organic matter content was determined using the ignition method (Smith, K.A. and Mullins, C.E, 1991). Soil pH was measured at a ratio of 1:2.5 in an aqueous suspension of soil using a portable pH meter (pH by HANNA). Data were statistically analyzed by using SAS version 9.1 Software and Microsoft Excel 2007.
According to table 2, significant differences could be seen in D leaf length with all the treatments. Very strong significant different could be seen between T1, T3, T6 and T7 treatments. Treatment 7 (T7) shows the highest length of D leaf and it has been received a recommended synthetic fertilizer only. This may be attributed due to rapid mineralization of chemical fertilizer and availability of nitrogen to the plant. The lowest D leaf length has shown in the T6, where 100% POME has been given as a fertilizer and it could be due to slow breakdown of organic compounds and realizing available nitrogen to the plant.

There are significant differences in number of leaves per plant between T4, T6 and T7. The difference of the number of leaves per plant is also highly significant in T7 and this also could be due to availability of nitrogen to the plant quicker than to that of in the form of POME. It has been shown that among the three major nutrients, nitrogen is required mostly during the first five months of growth by Obiefuna, (1987). In chemical fertilizer, mineralization and nutrient releasing is quicker than organic fertilizer such as POME.

There are significant differences in spade meter chlorophyll content of D leaf among all the treatments. Treatment 7 (T7) shows the highest spade meter chlorophyll content of D leaf. The initial D leaf chlorophyll content in T7 also was the highest and it has continued trough out the experiment irrespective to the treatment differences.

### Table 2- Estimated mean rank sum pineapple plants growth performances from field planting to eight months for seven treatments.

| Treatment | Leaf length (cm) of D* leaf | No. of leaves per plant | Chlorophyll content (Spade meter units) of D* leaf |
|-----------|-----------------------------|-------------------------|-----------------------------------------------|
| T1        | 64.17<sup>e</sup>          | 26<sup>bc</sup>         | 64.6<sup>e</sup>                               |
| T2        | 54.83<sup>cd</sup>         | 24<sup>ab</sup>         | 58.07<sup>c</sup>                             |
| T3        | 49.5<sup>b</sup>           | 22<sup>ab</sup>         | 53.57<sup>b</sup>                             |
| T4        | 59.83<sup>d</sup>          | 25<sup>ab</sup>         | 61.4<sup>d</sup>                              |
| T5        | 52.83<sup>bc</sup>         | 23<sup>ab</sup>         | 56.77<sup>c</sup>                             |
| T6        | 44.83<sup>a</sup>          | 20.33<sup>a</sup>       | 48.9<sup>a</sup>                              |
| T7        | 69.33<sup>f</sup>          | 28<sup>8</sup>          | 66.43<sup>f</sup>                             |

Means represented by the same letter are not significantly different at P < 0.05 significant level

[D* - leaf is the most recently matured leaf with maximum physiological activity]

2.1. Effect of different fertilizer application in growth performance of pineapple plants with time.
According to graph 1(1), the highest D leaf length was observed in T7 plots where the 100% chemical fertilizer applied. Whitest lowest was recorded in T6 where 100% POME was received as fertilizer. This could be attributed due to rapid mineralization of chemical fertilizer and available plant nutrient to intercrop. During the initial months (2nd month to 4th month) there is very slow increment of D leaf length and this was irrespective to the treatments and due to heavy rainfall received during this period. It is very clear that if to be seen the impact of POME and D leaf length the time period conducted the trial is not significant as the chemical fertilizer can give nitrogen fertilizer than to that of POME (Wu et al., 2009).

There were significant differences observed in number of leaves per pineapple plant among the treatment. The highest number of leaves per pineapple plant was observed in T7 where 100% chemical fertilizer was given and T6 received the lowest number of leaves per pineapple plant where 100% POME was given. This may be due to more availability on nitrogen to plants. During the months of 6th and 7th there was slight reduction of the rate of increasing number of leaves and it was due to dry spell of experienced during this part of the period. To minimize the water losses the plants may have adopted this mechanism.

Also we can see that there is a gap between T2 and T5 where same treatment combination given with and without cover crop. There the trial plots with cover crop have recorded higher number of leaves per pineapple plant than to that of without cover crop plots. This may be due to adaptation of minimizing losses of water (D.P. et al., 2002) through evaporation. Therefore we can see a relationship between cover crop and number of leaves per pineapple plant in this trial. This will further proven by the results of T3 and T6 as the same aspect.
According to graph 1(3), significant differences were observed in SPAD meter chlorophyll content between almost all the treatments. The highest chlorophyll content recorded in T7 where 100% chemical fertilizer given whilst lowest was reported from T6 where 100% POME was applied. This was due to quick and fast replacement of plant nutrients from chemical fertilizers and slow breakdown of organic fertilizer in the soil.

There is a trend that positive impact on chlorophyll content of D leaf in pineapple plants where the cover crop is established against no cover crop plants (Souza et al., 2015). Therefore we can assume that existence of cover crop will lead to move productivity in pineapple in a long run as an intercrop in oil palm.

**Ground cover efficiency**

By using double row system within eight months ground was covered by pineapple plants. The planting of the pineapple between inter-rows of the oil palm facilitates field maintenance of the plantations. After ground was covered by the pineapple; weed growth and soil erosion were got reduced.

| Soil physical and chemical character | Treatment | Value before intercropping | Value at the end of the experiment (8 months after intercrop application) |
|-------------------------------------|-----------|-----------------------------|---------------------------------------------------------------------|
| 1 Colour                            | T1        | Yellowish brown             | Yellowish brown                                                     |
|                                     | T2        | Yellowish brown             | Olive brown                                                         |
|                                     | T3        | Yellowish brown             | Dark brown                                                          |
|                                     | T4        | Yellowish brown             | Yellowish brown                                                     |
|                                     | T5        | Yellowish brown             | Olive brown                                                         |
|                                     | T6        | Yellowish brown             | Dark brown                                                          |
|                                     | T7        | Yellowish brown             | Yellowish brown                                                     |
| 2 Moisture content                  | T1        | 17.485                      | 11.942                                                              |
|                                     | T2        | 16.972                      | 10.532                                                              |
|                                     | T3        | 15.676                      | 11.697                                                              |
|                                     | T4        | 15.276                      | 10.672                                                              |
|                                     | T5        | 16.865                      | 7.944                                                               |
|                                     | T6        | 17.386                      | 6.534                                                               |
|                                     | T7        | 16.927                      | 14.148                                                              |
| 3 Organic matter content           | T1        | 6.943                       | 10.396                                                              |
|                                     | T2        | 7.051                       | 10.869                                                              |
|                                     | T3        | 7.111                       | 14.293                                                              |
|                                     | T4        | 7.002                       | 8.208                                                               |
|                                     | T5        | 6.874                       | 10.127                                                              |
|                                     | T6        | 7.585                       | 11.427                                                              |
|                                     | T7        | 6.742                       | 7.531                                                               |
| 4 pH (H₂O)                          | T1        | 5.9                         | 5.7                                                                 |
|                                     | T2        | 5.8                         | 5.6                                                                 |
|                                     | T3        | 5.7                         | 5.1                                                                 |
|                                     | T4        | 4.9                         | 4.7                                                                 |
|                                     | T5        | 5.5                         | 5.3                                                                 |
|                                     | T6        | 5.3                         | 5                                                                    |
|                                     | T7        | 5.1                         | 4.5                                                                 |

According to the table 3, soil colour was changed at the end of the experiment in contrast to the beginning of the experiment. This may be due to addition of organic amendment, such as POME, leaf litter from cover crop and intercrop. Highest level of colour increment recorded in POME applied plots. It can be concluded that POME will help to improve soil organic matter content and colour.
Soil moisture comparison was done in the experimental plots at the start and end. This revealed that there was a clear improvement of soil moisture levels in the plots that had cover crop with pineapple. The lowest moisture content at the experiment was recorded in T6 where 100% POME given to pineapple without cover crop. The reduction of moisture would have been due to evaporation losses and water uptake by the pineapple (Subin et al., 2013). Lowest reduction of soil moisture was seen in T7, where the 100% chemical fertilizer was given to pineapple with cover crop. It is clearly shown that cover crop has played a vital role of conservation of moisture irrespective of the nature of nutrient supplement used. But there is a trend where POME was applied plots have shown same encouraging amount of moisture retention throughout the experiment.

There is a good trend in soil organic matter (OM) content in plots at the end of the experiment. It could be seen that 100% increment in soil OM content in T3 where the 100% POME received with cover crop. Lowest soil OM content increment recorded in T7 where the 100% chemical fertilizer given plots. In the T4 soil OM content was not increased as the other plots where the POME was received. This could have been due to lower quantity of POME and cover crop was not established in this treatment plots. Overall it could be concluded that addition of organic amendments such as POME has significantly contributed to improvement of soil organic matter (Subin et al., 2013) and this has been well supported by the existence of cover crop in trial plots.

When the comparison of pH was done of the beginning and end of the experiment; it could clearly see that the highest pH reduction reported in T7 where the trial plots received 100% chemical fertilizer. It is obviously that addition of nitrogen fertilizer will reduce the soil pH due to addition of more H⁺ to the soil solution. All the other treatments have shown favorable fluctuation of pH and values are well adapted to both oil palm and intercrop. This could be due to addition of POME and this organic amendment have been reacted as a buffering agent to against the increment of H⁺ in soil solution (Chirs et al., 2011).

IV. CONCLUSIONS

It shows the highest length of D leaf due to rapid mineralization of chemical fertilizer and availability of nitrogen to the plant. The lowest length has shown in the T6. There 100% POME has been given as a fertilizer and it could be due to slow breakdown of organic compounds and realizing available nitrogen to the plant. The number of leaves per plant is also highly significant in D. incanum cover crop with pineapple intercrops and this too could be due to availability of Soil colour was changed at the end of the experiment in contrast to the beginning of the experiment. This may be due to addition of organic amendment, such as POME, leaf litter from cover crop and intercrop. Highest level of colour increment recorded in POME applied plots. It can be concluded that POME will help to improve soil organic matter content and colour.

Addition of organic amendments such as POME has significantly contributed to improvement of soil organic matter and this has been well supported by the existence of cover crop in trial plots.

Addition of nitrogen fertilizer will reduce the soil pH due to addition of more H⁺ to the soil solution. Also addition of POME has been reacted as a buffering agent to against the increment of H⁺ in soil solution.

Pineapple is a suitable crop for intercrop under young oil palm plantation (1 – 3 ½ years). To come to a firm recommendation on POME as an organic amendment and performance of pineapple, research should be continued for at least more than two yield cycles.

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