Investigation of underlying causes for sudden tea bush death and feasibility of applying decanter cake of oil palm (*Elaeis guineensis*) as an organic fertilizer in tea

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1. Introduction

Synthetic fertilizer application has been practiced in many tea plantations of Sri Lanka over decades and consequently, some environmental issues are encountered. To overcome these environmental issues, replacement of synthetic fertilizer by natural manure application is promoted in tea plantations (Ji et al., 2018). Yet, finding required amount of manure is a challenge and thus, alternative sources are experimented.

During oil palm processing, oil palm mill effluent generates several waste products such as empty fruit bunches (EFB), palm kernel shell (PKS) and decanter cake (DC). These products contain water (~76%), residual oil (~12% on dry basis) and nutrients such as N, P_2O_5, K_2O, CaO, MgO, cellulose, lignin, and ash (Maniam et al., 2013). Therefore, such wastes are used as fertilizer for tea in some plantations like Watawala Plantations PLC. However, there is an issue related to the DC application as several tea bushes have shown dieback after application. Therefore, this experiment focused on looking into the scientific background of possible causes for dieback of tea bushes while applying DC of oil palm as an organic manure.

The general objective of this experiment was to investigate the underlying causes of sudden tea bush death with DC application which has a potential to be promoted as an organic fertilizer for tea fields. The specific objective was to investigate the physical and chemical changes of DC at different decomposition levels.

2. Materials and Methods

An experiment with three studies was conducted from January to April, 2021 in Nakiyadeniya at Thalangaha Division, Watawala Plantation PLCs, under Low Country Wet Zone (24-217 m.s.l.).

(I) Effects of decanter cake on soil physico-chemical properties

DC was heaped for four weeks and applied as 2 or 4 kg to a plot having 20 plants. A control was maintained without DC application. RCBD with three replicates was the experimental design.

After imposing treatments, soil samples were obtained at 0-15 and 15-30 cm depths. Following standard protocols, moisture content (MC), pH and electrical conductivity (EC) were measured. Total N and available P were determined following Kjeldahl method and Olsen method, respectively. Total organic carbon (OC) content was determined by ignition method.

(II) Investigation of fate of the DC heaped for decomposition

Fresh DC was decomposed for 4, 6 and 8 weeks, separately. Bulk density (BD) and other physico-chemical properties, as described above, were determined after 4, 6, and 8 weeks of decomposition and for the fresh DC.

(III) Physical observations of tea plant death

Five plots (Plot 1, 2, 3, 4 and 5), each having 100 plants, were demarcated and, totally and partially dead bushes were recorded. Then, five totally dead and five partially dead tea bushes were randomly uprooted; root systems, stems, leaves and branches were visually observed. Further information was collected from field officers through a questionnaire.

All data were subjected to one way ANOVA and means were separated following Tukey test. Minitab 17 was used.

3. Results and Discussion

(I) Soil physico-chemical properties after application of DC as a fertilizer

Significantly (P<0.05) highest total soil N was recorded at 0-15 cm depth with 4 kg DC decomposed for 4 weeks whereas the lowest was reported from control at 15-30 cm depth. Higher N content in treated plots could be attributed to the N amended with DC. There was no significant (P>0.05) difference in available P levels. Significantly (P<0.05) highest and the lowest OC was also recorded in the same treatments, as did for N above.

There was a significant (P<0.05) difference between soil MC based on depth: MC at 0-15 > MC at 15-30 cm. However, there was no significant (P>0.05) difference among MC based on amount of DC amended.

There was no significant (P>0.05) difference in soil pH values and EC values of the differently treated plots.

(II) Physical and chemical properties of decanter cake

pH, EC and BC of oil palm DC decreased over the time of decomposition (Table 1). MC ranged between 77.1 and 84.33% showing a decrease, over the time, except for 4 weeks. However, total OC, total N and available P gradually increased with the decomposition time. Decrease of BD, EC and pH together with increase of total OC, total N and available P of an organic compound is more favourable being a fertilizer. Therefore, allowing DC for 8 weeks period for decomposition is more favourable for DC to use as an organic fertilizer.

Table 01. Physico-chemical properties of oil palm decanter cake

DC decomposition (weeks)	pH	EC (µs/cm)	MC (%)	Total OC content (%)	Total N (%)	Available P (mg/kg)	BD ($g/cm^{3)}$
0*	6.57	668.0	84.33	41.36	3.2	1298.3	0.52
4	5.93	498.0	77.10	44.08	3.5	1381.4	0.39
6	5.52	328.7	83.93	47.56	3.8	1557.5	0.31
8	5.43	214.3	82.40	51.04	4.0	1640.6	0.24

*Fresh DC

(III) Physical observations on tea plant death

The highest totally dead (16%) and partially dead (27%) bushes were recorded in Plot 2. This might be due to the high amount of non-decayed DC dumped. The percentages of dead and partially dead bushes were significantly (P<0.05) lower in Plot 5: 7 and 9%, respectively, and may be due to the lowest amount of non-decayed DC amended.

Observations by field officers

8-year old tea bushes have been dead after adding fresh and non-decomposing DC very near to the tea bushes in 2018; some tea bushes were completely dead while the others showed a slight recovery.

Visual observation on dead and partially dead tea bushes

There were easily broken rotten black and brown root systems, stems, and branches with white-coloured fungal patches in dead and partially dead bushes. Death of bushes has started somewhere in 2018. Some feeder roots and termite-damaged patches were observed in both plants. These were seen because of the application of high-level, non-decomposed DC near the plant base.

4. Conclusions

Decomposed DC applied at the rate of 4 kg per tea plant is found to be more favourable for tea growth. Also, DC can be used as a fertilizer after allowing decomposing for at least 2-3 months' duration. Tea bush death in fields where decanter cake has been dumped is attributed to the dumping of very fresh DC just near the base of the plant. Fresh DC is very high in EC and therefor, plants cannot tolerate such a high level.

5. References

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