Heavy metals content in soils grown with cocoa and in the tissues of cocoa

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Introduction

There are reports regarding the presence of heavy metals in cocoa beans and products of which Cd, Cu, As and Pb are of great concern (Knezevic, 1979; Knezevic, 1980; Knezevic, 1982; Lee and Low, 1985; Jinap et al., 1991; and, Denamany et al., 1991). Studies by Lee and Low (1985) and Denamany et al. (1991) showed no evidence of heavy metals contamination during bean processing, transport and storage. It is likely that these heavy metals are present due to their uptake by cocoa plants from the soils. Therefore, this study was conducted to try to correlate soil parameters to trace elements concentrations in the leaves and beans of cocoa . This will reflect the influence of soil types on heavy metals uptake by cocoa. Also, from the correlation study, information can hopefully be gathered on the influence of cultural or management practices on heavy metal contamination .

Materials and Methods

Sampling of Soils, Leaves and Beans: Ten soil series namely Briah, Gong Chenak, Serok, Jawa, Sejacob, Kampung Pusu and Tok Yong (alluvial parent material) and, Segamat, Katong and Benta (andesitic parent material) were sampled. To relate soil properties and concentration of heavy metals in plants, paired soil and foliar and pods sampling was performed. Intact soil corer was used to take samples up to a depth of 60 cm. Two soil cores were taken at each sampling point which was situated between two cocoa trees, and for each site, six sampling points were identified for samples to be taken. The cores were sectioned into three parts, that is, 0-20, 20-40 and 40-60 cm depth and samples from each sampling point were composited. Foliar and cocoa pods were also sampled from the respective trees at each sampling points.

Analyses: The soils were analyzed for the following properties, that is, pH, organic C, cation exchange capacity (CEC) and soil texture. Soil pH was determined in a water suspension of soil using 1:2.5 soil /solution ratio. Cation exchange capacity was determined using ammonium acetate, pH 7.0 leaching method (Soil Survey Staff, 1998). Percent rganic C was determined using the modified Walkley and Black method (Page et al., 1982). Texture was determined by using the micro-pippette method (Miller and Miller, 1987). The aqua-regia digestion method was used for extracting heavy metals from the soil and the dry ashing method was used for the tissue samples. Cadmium and Pb in tissue was analyzed using the graphite furnace atomic absorption spectrophotometry and the other heavy metals were analyzed using flame atomic absorption spectrophotometry.

Results and Discussion

The mean concentrations of Cd, Cu and Ni in soils with andesitic parent materials are much higher than those soils formed from alluvial parent materials. On the other hand Pb and Zn are higher in soils developed on alluvial parent materials. The concentration of Cd, Cu and Ni cocoa tissues are higher in plants grown on soils with andesitic parent materials, and Pb and Zn are higher in plants grown on alluvial parent materials. Based on the maximum permitted concentration stipulated in Malaysian Food Act of 1983, Cd and Zn concentrations in cocoa beans have exceeded these MPC value (MPC value for Cd is 1 mg/kg and Zn is 40 mg/kg). Cadmium, Ni and Pb concentrations are higher in the leaves than the beans and the pods, where as Cu and Zn are higher in the beans.

Based on correlation study, the main factor which control the heavy metal content of the soil is the clay. The main factor which control extractable or available heavy metals is the pH of the soil. Besides these two factors, CEC is also important in influencing the behaviour of heavy metals in the soil. Correlation analyses also indicated that Cd content in the tissues is significantly correlated with available P content of the soil. This reflects the contribution of Cd from the phosphate rock fertilizers applied to the soil

Conclusions

The soil type influenced the distribution as well as the uptake of heavy metals from the soil. In this study soils developed on andesitic parent materials tend to contribute significantly to the Cd, Cu and Ni uptake by the cocoa plants. Soils developed on alluvial parent materials tend to contribute significantly to the uptake of Pb and Zn.

Management practice of applying phosphate rock as a source of P fertilization contributes to Cd contamination in the cocoa plantation.

Benefits from the study

Generation of new scientific information and availability of option for sustainable management of cocoa plantation.

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Nil

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Expertise Development

	Name of Graduate	Degree Awarded	Field of Expertise	Graduation Year
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