ABSTRACT

Soil quality or health, is important in determining the agricultural sustainability. Soil quality is mainly governed by soil organic matter (SOM). The quantity and quality of SOM may vary in arable systems depending on the crops and management practices. The present investigation was carried out to characterize soil properties and to quantify different SOM pools in the major land use patterns in rubber plantation in three locations where rubber cultivation is concentrated.

Leaf litter of *Hevea brasiliensis* (rubber), *Mucuna bracteata* and *Pueraria phaseoloides* being the major organic matter inputs in rubber growing soils, were chemically characterized and their decomposition was studied through litter bag technique. The study revealed that the three litter species *viz.*, *Hevea*, *Pueraria* and *Mucuna* varied in quality, decomposition process and nutrient release. Among the three species studied, *Pueraria* litter having more cellulose and less lignin and polyphenols decomposed at a higher rate whereas rubber litter having more lignin and polyphenols decomposed at a lower rate. The rate of release of N, P, K, Ca and Mg from the three litter species also varied and it could be seen that the release of nutrients were higher from the *Pueraria* litter followed by *Mucuna* and *Hevea*.

During the early stages (immature phase) of rubber plantation, intercropping with banana or pineapple or cover cropping with *Mucuna* or *Pueraria* is the common practice. Soils under mature as well as immature rubber systems were examined for soil quality at three locations *viz.*, Amayannoor, Mundakayam and Erumely in Kerala. The four systems studied at Amayannoor were mature rubber, rubber-*Pueraria*, rubber-banana and rubber-pineapple. At Mundakayam
mature rubber, rubber-\textit{Mucuna}, rubber-banana and rubber-pineapple systems were examined. Mature rubber, rubber-\textit{Pueraria} and rubber-\textit{Mucuna} systems were studied at Erumely.

Soil parameters studied were physical (bulk density, particle density, porosity and water stable aggregates) and chemical (OC, TN, CEC, available nutrients and pH) properties and labile carbon fractions in surface soil of these systems. Spectroscopic characterization of soil organic matter was also carried out. It was observed that different vegetation and management practices in rubber plantation had influenced the soil properties and organic matter quantity and quality. At location Amayannoor, soils under rubber-\textit{Pueraria} and rubber-banana systems showed better physical properties (porosity and water stable aggregates) compared to the other two systems. Organic carbon and labile pools of SOM, water soluble carbon (WSC) and hot water extractable carbon (HWEC) were also significantly higher in rubber-\textit{Pueraria} and rubber-banana systems than the other two systems. At location Mundakayam, porosity and water stable aggregates were higher in rubber-banana and rubber-\textit{Mucuna} systems. Even though OC status was significantly higher, in rubber-\textit{Mucuna} system, labile carbon pools (HWEC and POSC) were comparable with that of other systems at Mundakayam. Here also rubber-banana system showed significantly higher WSC compared to other systems. At both locations rubber-banana system was less acidic than other systems. Even though carbon status was higher in mature rubber at Erumely, WSC and HWEC were more in rubber-\textit{Pueraria} system compared to other two systems. Mature rubber and rubber-\textit{Pueraria} systems were comparable in water stable aggregates at this location.

In all the three locations, irrespective of the system, carbon content increased with decrease in soil particle size. It was observed that more than 70\% of the total soil carbon was associated with the smallest size fraction, viz., silt-clay sized fraction which has very little
contribution to short-term plant nutrition. UV-Vis and FTIR spectroscopic characterizations indicated more humification in mature rubber system compared to the immature systems at all locations. Spectroscopic characterizations also showed better SOM quality- more carbohydrates and polyssacharides and less aromaticity- in rubber–Pueraria system than the other systems in the immature phase, both at Amayannoor and Erumely. At Mundakayam, rubber- banana system showed better SOM quality compared to rubber-pineapple and rubber–Mucuna systems. The relatively much higher contents of labile C pool can contribute significantly towards nutrient release, especially in the growing phase of rubber.

Incubation study conducted to understand the carbon mineralization in different rubber based systems indicated that SOM decomposition was influenced by organic matter quality. The rate of carbon mineralization of the various systems at Amayannoor, was in the order rubber–Pueraria > rubber–banana = rubber- pineapple > mature rubber. Since carbon mineralization was highly correlated with WSC, HWEC, POSC and carbon content in macro sized fraction these labile C fractions can be used as soil quality indices in rubber growing soils.

The study revealed that during the growing phase of rubber, Pueraria is more beneficial in improving soil quality than Mucuna as a cover crop. Banana is a better intercrop than pineapple in improving soil quality in rubber based system. Pineapple cultivation in rubber system had adversely affected the soil quality. The SOM under mature rubber system had undergone more condensation and may remain in the system for longer periods which would be environmentally beneficial.

Key words: Carbon mineralization, Characterization, Litter, Rubber based systems, Soil organic matter, Soil quality.