COMPARISON OF SELECTED BIOCHEMICAL SOIL HEALTH INDICATORS OF TARO SOILS IN SAMOA

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Introduction

Microbial activity appears to be excellent indicators of soil health because they respond quickly to changes in the soil ecosystem and have intimate relations with their surroundings due to their high surface to volume ratio. In some instances, changes in microbial populations or activity can precede detectable changes in soil physical and chemical properties, thereby providing an early sign of soil improvement or an early warning of soil degradation. Since microorganisms are involved in many soil processes, they may also give an integrated measure of soil health, an aspect that cannot be obtained with physical/chemical measures alone (Huber *et al.*, 2001).

More than 90% of energy flow in a soil system passes through microbial decomposers. Consequently, total microbial activity of microbial decomposers is a good general measure of organic matter turnover and a good indicator of soil health. Total microbial activity can be measured using a fluorescein diacetate (FDA) test. FDA hydrolysis has been proposed as a promising measure for predicting organic matter suppressiveness (Bonanomi *et al.*, 2010). However, it should be noted that soil biological characteristics can vary substantially both in space and time precluding straightforward association between them and land management practices.

Methodology

Soil sampling and analysis

Soil samples were obtained from a multi location field trial was established on four sites (two in the high rainfall zone and two in the low rainfall zone) on the two main islands of Samoa namely Upolu and Savaii. This field trial is being conducted to assess the effects of improved fallow on the biological functioning of continuously cropped taro fields. The experiment includes two fallow types: the farmers fallow and the mucuna fallow. Soil samples (0-15 cm deep) were collected at bimonthly intervals to evaluate the three biochemical parameters: fluorescein diacetate hydrolysis activity, labile carbon and anaerobic mineralisable nitrogen. Soil pH was also measured in all of the four site.

Statistical Analysis

All the data collected was subjected to analysis of variance for spatial variability of all the three biochemical parameters as well as soil pH. Correlation analyses were carried out to determine any significant association between the parameters evaluated.

Results and Discussion

Spatial heterogeneity of the evaluated soil parameters

Table 1 shows the spatial variability of the evaluated biochemical properties from the four sites. Significant differences were found ($P<0.05$) between the four sites for soil pH and labile carbon. Soil biological activity (FDA) and anaerobic mineralisable nitrogen (AMN) differed significantly between the sites from the two islands, however, no significant difference was found between sites from the same island except for FDA from Savaii sites. The observed differences can partially be explained by average rainfall differences as influenced by the two zones as well as inter island differences. However, higher values for pH, labile C and FDA in the Aopo site can be attributed the effects of burning practiced during clearing.

Associations between the evaluated soil biochemical indicators

Table 2 outlines the details of associations between the various indicators evaluated during the study. Significant associations ($P<0.05$) were found between labile C and soil microbial activity, labile C and soil pH and soil biological activity and soil pH. The anaerobic mineralisable nitrogen (AMN) was only moderately correlated with labile C; however, no significant correlations were found between soil biological activity and AMN.

Conclusion and Recommendation

Soil pH can reasonably be used to estimate and/or predict the biological functioning of Samoan taro soils as it correlates significantly with labile C, soil biological activity as well as AMN. Labile C levels in the soil are strongly affected by microbial activity. Microbial activity is required to decompose organic matter and recycle nutrients. Therefore, it is evident that both these biochemical indices partially give an integrated measure of biological functioning of soils and both are largely affected by land management practices.

Literature Cited

Bonanomi G, Antignani V, Capodilupo M, Scala F. 2010. Soil Biol. Biochem. 42: 136-144

Huber S, Syed B, Freudenschuss A, Ernstsen V, Loveland P. 2001. Proposal for a European soil monitoring and assessment framework. Technical report no. 61, European Environment Agency, Copenhagen, Denmark.

Table 1. Biochemical indicators of soil health as affected and rainfall zone.

Island	Site	Rainfall Zone	No. of Observations	Soil pH	Labile C (mg/kg)	FDA (mg/kg)	AMN (mg/kg)
Upolu	Salani	High	24	5.50 *d*	645.00 *d*	66.20 *c*	19.58 *bc*
	Safaatoa	Low	24	5.61 *c*	773.80 *c*	63.10 *c*	16.67 *c*
Savaii	Siufaga	High	20	5.99 *b*	985.30 *b*	82.80 *b*	20.50 *ab*
	Aopo	Low	20	6.26 *a*	1406.70 *a*	114.60 *a*	25.50 *a*
Least significant difference (5%)		Min reps		0.090	55.41	10.53	5.83
		Max – Min		0.086	53.05	10.08	5.58
		Max reps		0.082	50.58	9.61	5.32

Table 2. Correlation analysis between the indicators.

Variable X1	Variable X2	Pair of Observations	r-value	p-value
Labile C	FDA	88	0.7343	0.0000 *
Labile C	AMN	88	0.2302	0.0309*
FDA	AMN	88	0.0786	0.4667ns
pH	Labile C	88	0.8749	0.0000*
pH	FDA	88	0.5716	0.0000*
pH	AMN	88	0.3102	0.0033*