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# Biochemical fertility index and enzyme activity of mid-laterite soils in coconut-growing systems in Kerala (AEU 9)

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**Abstract**

Natural processes such as nutrient mineralization, organic matter production, soil fertility, and cycling are regulated by enzymes. The biological, chemical, and physical characteristics of the soil are closely related to them. The purpose of the experiment was to measure the levels of various enzymes found in soil in five different cropping systems involving coconut: Coconut+Fodder, Coconut+Banana, Coconut+Pepper, Coconut+Tuber, and Coconut+Vegetable. These systems were grown using either organic or conventional farming methods. The enzymes included dehydrogenase, acid phosphatase, glucosidase, protease, amylase, and catalase. The biologically productive agricultural system in Kerala's mid-laterite soils (AEU 9) is another important consideration. The levels of dehydrogenase, acid phosphatase, and catalase were higher in coconut + bananas grown under an organic farming system. The levels of glucosidase and amylase were higher in coconut + peppers grown under an organic farming system. The levels of protease were higher in coconut + tubers grown under an organic management system. Organic farming settings revealed that banana and coconut cropping were the most successful of all the cropping systems tested.

**Keywords:** coconut based cropping system, dehydrogenase, acid phosphatase, glucosidase, protease, catalase, amylase, enzyme activity number

## 1. Introduction

2. The primary sources of enzymes in soils include plants, soil, animals, and microbes that are covalently, cross-linked, copolymerized, adsorbed, and incorporated into the microcapsules of soil particles (Girish and Ajit, 2011) [12]. Because of their connection to soil biology, operational practicality, sensitivity, integrative nature, ease of measurement, and description as "biological fingerprints" of previous soil management, soil enzymes have been reported as helpful indicators of soil quality (Utobo and Tewari, 2014) [22]. The production, conversion, and breakdown of organic materials into forms that plants can digest, the breakdown of xenobiotics, the cycle of nitrogen and other elements, and the life cycle of soil microbes all depend on soil enzymes (Dick and Tabatabai, 1992) [9]. In order to assess soil quality, climate change, ecosystem damage, and toxification, soil enzyme activity have been used as indicators. Seasonal variations in soil enzyme activity have been linked to soil physiochemical characteristics, microbial community structure, vegetation, disturbance, and succession (Caldwell, 2005) [5]. One of the primary elements of soil enzymatic activities that participate in and guarantee the proper order of all the biochemical pathways in soil biogeochemical cycles are soil dehydrogenase enzymes. Because they are found intracellularly in all live microbial cells, dehydrogenases are among the most significant enzymes in the soil environment and are employed as a gauge of total soil microbial activity (Salazar et al., 2011) [17].By moving protons and electrons from substrate to acceptors, the enzyme dehydrogenase oxidizes soil organic matter. Although this enzyme does not build up extracellularly in the soil, it is thought to be an essential component of intact cells (Das and Varma, 2011) [7]. Acid phosphatases play a significant role in the supply and metabolism of phosphate in plants by catalyzing the non-specific hydrolysis of inorganic phosphate from phosphate monoesters in pH ranges between 4 and 6 (Tabaldi et al., 2007) [19]. After hydrolysis and the release of free phosphate, organic phosphorus, which is plentiful in soil, may aid in the P feeding of microorganisms and plants. Phosphatase enzymes, which are released into soil, catalyze this process (Miller et al., 2001) [16]. Enzymes known as "phosphatases" that catalyze the hydrolysis of phosphoric acid esters and anhydrides are often responsible for the mineralization of P compounds in soil. Because it catalyzes the hydrolysis and biodegradation of different β-glucosidases found in plant waste decaying in the environment, Jn

B-glucosidase is a significant enzyme in soils (Martinez and Tabatabai 1997) [15]. An enzyme that breaks down cellulose is crucial to the soil organic carbon cycle (Esen, 1993) [11]. Protease activity plays a significant role in the ecology of microorganisms in the ecosystem and is a measure of the biological capacity of the soil for the enzymatic conversion of the substrate, regardless of the level of microbial activity (Burns, 1982) [4]. Soil protease, which is more active in forest soils and landfills with high humus and water contents, is important for nitrogen mineralization. Catalase breaks down peroxide, and its activity is influenced by the quantity of organic oxygen, microbial biomass, variations in CO2, and the activity of dehydrogenase, amidase, glucosidase, and esterase in soils (Burns, 1982) [4]. In well-aerated conditions, soil catalase activity is increased (Brzezinska et al., 2005) [3]. Plants, animals, and microbes all produce $f_0$-amylases, although plants are the primary producers of β-amylase (Thoma et al., 1971) [21]. Widely found in plants and soils, amylase is an important component in the breakdown of starch, converting starch-like substrates to glucose and oligosaccharides, which in turn transforms starch to maltose (Thoma et al., 1971) [21].

## 3. Materials and Methods

In the mid-laterite soils of Kerala's Kollam district, soil samples were taken from five distinct coconut-based cropping systems under two farming techniques: organic and conventional (Agro Ecological Unit). AEU 9. Dehydrogenase, acid phosphatase, glucosidase, protease, catalase, and amylase activity were measured in each soil sample. The technique outlined by Casida et al., 1964 [6] was used to test the dehydrogenase activity. 3% 2, 3, 5-triphenyl tetrazolium chloride (TTC) was used to assess the dehydrogenase activity. Using triphenyl formazon (TPF) as a standard, a standard graph was created to determine the concentration of dehydrogenase in the sample. µg of TPF emitted g-1 soil 24 h-1 was used to express the enzyme activity. The technique described by Tabatabai and Bremner (1969) [20] was used to test the acid phosphatase activity of soils. 0.05 M p-nitrophenyl phosphate was used to evaluate the acid phosphatase activity. On a dry weight basis, the enzyme activity was measured in µg of p-nitrophenol emitted g-1 soil h-1 at 37 0 C and pH 6.5.

Using 0.5 M p-nitrophenyl β–glucopyranoside, the Eivazi and Tabatabai (1988) [10] technique was used to estimate the activity of glucosidase in soil samples. The glucosidase activity was measured in µg pnp D-glucosidase g-1 soil h-1 x 10-4. The Kunitz M. (1947) [14] technique was used to assess the soil protease activity, which is expressed in µM of amino nitrogen hydrolyzedg-1 soil h-1. The Bach A.N. and Zubkova S.M. method was used to measure soil catalase activity, which was represented as a percentage of H2O2 hydrolyzed g-1 soil h-1. The method for determining amylase activity in soil samples was described by Bernfeld (1955) [2].

Based on the activity of five distinct enzymes—dehydrogenase, catalase, acid phosphatase, protease, and amylase—the Biological Fertility Index for the various treatment combinations was calculated using the enzyme activity number established by Beck (1984). The formula was used to calculate the Enzyme Activity Number for each treatment. EAN is equal to 0.2{TPF + catalase (%)/10 + phenol (µg)/40 + amino-N (µg)/40 + amylase (%)/20}.

### Statistical Analysis

The data generated from the experiments were subjected to the Analysis of variance as per the design, Factorial CRD and their significance was tested using F test (Snedecor and Cochran, 1975) [18]. Critical difference (CD) was calculated at 0.05% probability levels using statistical tools.

## 5. Results and Discussion

According to the research, the coconut+banana cropping system under organic farming had the maximum dehydrogenase activity (462.52 µg of TPF released g-1 of soil 24 h-1) (Table 1). Higher dehydrogenase activity may have resulted from an increase in the number of microorganisms, particularly bacteria, in the soil caused by an organic farming method. Wells et al. (2000) [24] found a similar rise in dehydrogenase activity with the addition of FYM/vermicompost, whereas the traditional farming system of Coconut + Tuber had the lowest dehydrogenase activity (101.25 µg of TPF released g-1 of soil 24 h-1) (Fig. 1). The organic Coconut + Banana farming system has the greatest acid phosphatase activity (80.35 µg of p-nitrophenol emitted g-1 of soil 24 h-

1) (Table 1 & Fig. 2). The low available P status may be the reason for the maximum acid phosphatase activity seen in these treatments. According to Versaw and Harrison (2002) [23], acid phosphatase secretion from plant roots increases if there is a signal signaling a P deficit in the soil. This enhances the solubilization and remobilization of PO4, hence altering the capacity to deal with P-stressed conditions. Coconut + Pepper (4.1 µg pnp D-glucosidase g-1soil h-1X 10-4) and Coconut + Tuber had the greatest β-glucosidase activity (Table 1). The organic farming approach was generally shown to be favorable for β-glucosidase activity. The findings that microbial development favors the release of β-glucosidase in this kind of environment (Dick, 1994) [8] and that the traditional farming system of Coconut+Vegetable showed the lowest β-glucosidase activity (1.53 µg pnp D-glucosidase g-1 soil h-1X 10) further confirm this. -4) (Fig. 3). Protease activity was greatest in the Coconut+Tuber cropping system (188.84 µM of amino nitrogen hydrolyzed g-1 of soil h-1) (Table 1 & Fig. 4). This might be explained by the greatest levels of water-holding capacity, organic carbon, mineralizable nitrogen, and accessible K. Soil fertility and the quantity of aerobic microorganisms have been linked to catalase activity, which is regarded as an indication of aerobic microbial activity. Catalase activity was lowest in Coconut + Vegetable (Fig. 6) and greatest in Coconut + Banana (2.85% of H2O2 hydrolyzed g-1 of soil h-1) cropping system (Table 1), which was comparable to Coconut + Pepper (2.64% of H2O2 hydrolyzed g-1 of soil h-1). According to the experiment, Coconut+Pepper had the maximum amylase activity (13.82 µ² of maltose g-1 of soil) under the organic management method (Table 1 & Fig. 5). Similar patterns were noted by Griffiths et al. (1999) [13] when examining the impact of different C substrate rates on amylase activity. Regarding the EAN as suggested by Beck (1984) [1], Table 2 shows that the primary impacts of Coconut + Banana (94.01) under an organic way of agriculture had the greatest EAN. The study clearly shows that the highest values of catalase (3.9% of H2O2 hydrolyzed g-1 of soil hr-1), acid phosphatase (80.35 µg of p-nitrophenol released g-1 of soil 24 h-1), and dehydrogenase (462.52 µg of TPF released g-1 of soil 24 h-1) observed in Coconut+Banana under organic system may have contributed to the highest enzyme activity.

**Table 1:** Enzyme activities of the soils of coconut based cropping systems AEU 9

| Treatments | Dehydrogenase (µg of TPF released $g^{-1}$ of soil 24 $h^{-1}$) | Acid phosphatase (µg of p nitro phenol released $g^{-1}$ of soil 24 $h^{-1}$) | Glucosidase (µg pnp D-glucosidase $g^{-1}$ soil $h^{-1}$ x $10^{-4}$) | Protease (µM of amino nitrogen hydrolysed $g^{-1}$ of soil $h^{-1}$) | Catalase (% of $H_2O_2$ hydrolysed $g^{-1}$ of soil $h^{-1}$) | Amylase (µM of maltose $g^{-1}$ of soil) |
|---|---|---|---|---|---|---|
| Coconut + Fodder ($C_1$) | 221.46 | 52.44 | 3.06 | 84.94 | 2.02 | 8.98 |
| Coconut + Banana ($C_2$) | 326.92 | 56.23 | 2.51 | 165.84 | 2.85 | 9.44 |
| Coconut + Pepper ($C_3$) | 276.42 | 42.19 | 3.64 | 149.7 | 2.64 | 9.7 |
| Coconut + Tuber ($C_4$) | 212.87 | 55.95 | 3.27 | 174.98 | 2.32 | 9.16 |
| Coconut + Vegetable ($C_5$) | 184.3 | 45.76 | 2.12 | 172.17 | 1.96 | 9.01 |
| Organic Farming ($F_1$) | 344.49 | 59.89 | 3.37 | 163.22 | 3.05 | 12.31 |
| Conventional Farming ($F_2$) | 144.29 | 41.14 | 2.47 | 135.84 | 1.67 | 6.21 |
| $C_1F_1$ | 311.83 | 56 | 3.51 | 99.34 | 2.54 | 9.8 |
| $C_2F_1$ | 462.52 | 80.35 | 2.8 | 186.37 | 3.9 | 12.52 |
| $C_3F_1$ | 368.38 | 47.26 | 4.1 | 161.46 | 3.54 | 13.82 |
| $C_4F_1$ | 321.49 | 58.68 | 3.75 | 188.84 | 2.74 | 12.7 |
| $C_5F_1$ | 258.22 | 57.13 | 2.72 | 180.07 | 2.52 | 12.7 |
| $C_1F_2$ | 131.08 | 48.87 | 2.61 | 70.54 | 1.5 | 8.16 |
| $C_2F_2$ | 191.32 | 32.11 | 2.23 | 145.32 | 1.8 | 6.36 |
| $C_3F_2$ | 184.45 | 37.11 | 3.18 | 137.95 | 1.74 | 5.58 |
| $C_4F_2$ | 101.25 | 53.2 | 2.79 | 161.11 | 1.9 | 5.62 |
| $C_5F_2$ | 110.37 | 34.37 | 1.53 | 164.27 | 1.4 | 5.32 |
| CD- C (0.05) | 21.66 | 6.29 | 0.14 | 19.05 | 0.23 | 0.25 |
| CD- F (0.05) | 13.69 | 3.98 | 0.06 | 12.05 | 0.14 | 0.16 |
| CD- C F(0.05) | 30.63 | 8.91 | 0.14 | NS | 0.32 | 0.35 |

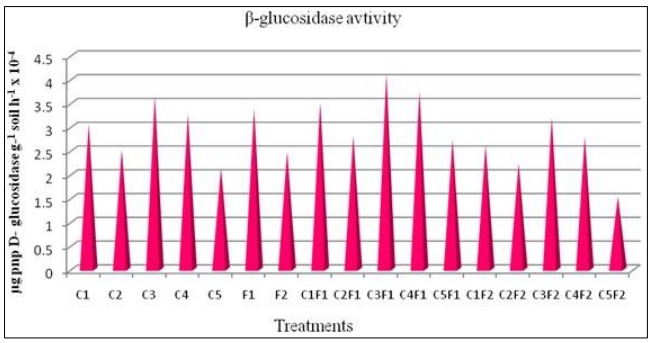


**Fig 3:** β-glucosidase activity of the soils under coconut based cropping system AEU 9

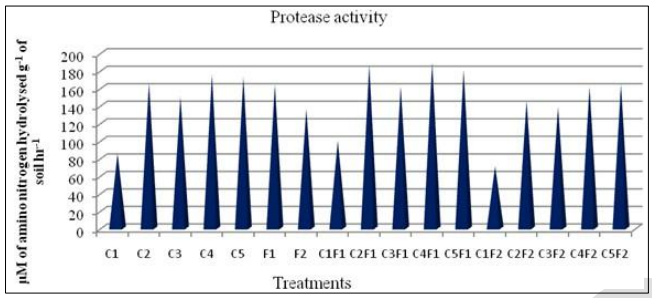


**Fig 4:** Protease activity of the soils under coconut based cropping system AEU 9

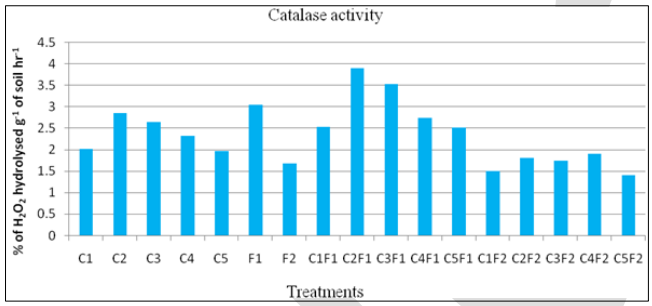


**Fig 5:** Catalase activity of the soils under coconut based cropping system AEU 9

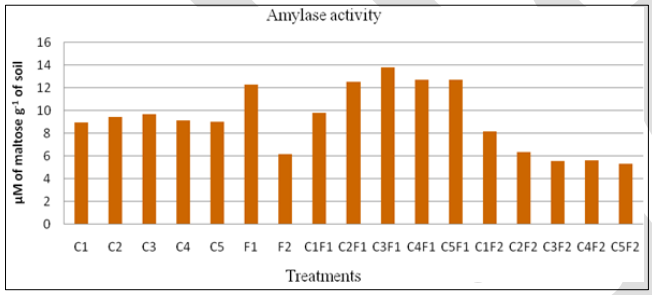


**Fig 6:** Amylase activity of the soils under coconut based cropping system AEU 9

**7. Conclusion**

**8.** The research found that out of all the cropping and farming systems tested, the organic method produced the most biologically fertile and long-term sustainable coconut and banana crops. This was due to the fact that the organic system had the highest enzyme activity numbers (EAN) and the highest levels of dehydrogenase, acid phosphatase, and catalase.

**9. References**

**10.** 1. Beck T. Soil microbiological analysis methods and applications at the Landesanstalt für Bodenkultur und Pflanzenbau (LLB) in Munich for the identification of certain soil fertility features 2. Paper presented at the Conference on Biological Indicators of Soil Fertility, edited by Nemes, Kiss, Papacostea, Stefanic, and Rusan,

MP. Bucharest, Romania: Romanian National Society of Soil Science, Fifth Symposium on Soil Biology, 1984, 12-30p. Zweig, P. Methods in Enzymology. 1955, pp. 149 to 158.The impact of oxygen shortage on soil dehydrogenase activity in a triticale pot experiment was examined by Brzezinska, Stępniewski, Stępniewska, and Przywara in their international agrophysics publication. 145–149 (2001). Soil enzyme activity (Burns RG, 2004). In the 1982 issue of Soil Biology and Biochemistry, the article cited is 14:425. Fifth, Caldwell BA. Soil biodiversity and enzyme activities: a literature review. Environmental biology. 50:637-644, 2005. 6. Soil dehydrogenase activity was investigated by Casasida LE, Klein DA, and Santoro T. Journal of Soil Science. 1964; 98:371-376. 7. The Function of Enzymes in the Preservation of Healthy Soils (Das SK, Varma A.). "Soil Enzymology and Soil Biology" (eds. Shukla and Varma, 2011), 22. Soil inorganic pyrophosphatase activity (Dick RP, Tabatabai MA, 2008). Biology and Biochemistry of Soils. Volume 10, pages 58–65, 1992. 9. R. Dick (1994). Soil enzymes as markers of soil quality. The 1995 issue of the Journal of the Soil Science Society of America was 35:107–129. 10. Glucosidases and galactosidases in soils from Eivazi F and Tabatabai MA. Biology and Biochemistry of Soils. 1-606 (1988) The overview of $\beta$-glucosidases by Esen A. Published by the American Chemical Society in Washington DC in 1993, in the book "Glucosidases and Molecular Biology" edited by Esen, A. 12. Girishh S. and Ajit V., "Soil Enzymology" (2011), 12-16. 13. Griffith BS, Ritz K, Ebblewhite N, and Dolson G. The impact of substrate loading rates on the organization of soil microbial communities. Biology and Biochemistry of Soils. 1949; 31: 145–153. Figure 14. Kunitz M. Crystalline Soybean Trypsin Inhibitor II. Overview of Characteristics. The Journal of Physiology (General Edition). pp. 291–310, 1947. Martinez CE and Tabatabai MA were the authors of the 15th work. Decomposition of biotechnology by-products in soils. Environmental Quality Journal. pp. 625–632. 1997. 16, Miller SS, Liu J, Allan DL, Nezuhuber CJ, Fedrova M, Vanu CP. How protenoid roots secrete acid phosphatase: a molecular perspective. The article is published in the Journal of Plant Physiology and has the keywords 127:594-606. In 2011, Salazar et al. (17) conducted research. How various methods of forest system management affect the activity of soil enzymes. Journal of Ecological Engineering, 2011; 37: 1123-1131. 18. Statistical Methods by Snedecor and Cohran. With 593 pages, Oxford and IBH Publishing Company, New Delhi, 1975. 19. The impact of metal elements on acid phosphatase activity in cucumber (Cucumis sativus L.) seedlings was studied by Tabaldi LA, Ruppenthal R, Cargnelutti D, Morsh VM, Pereira LB, Schetinger MRC, and colleagues. The field of experimental and environmental botany. 1997; 59:43–48.