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IMPORTANCE OF SOIL ENZYME IN SOIL ECOLOGY

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Soil Enzymes:

Soil enzymes are a group of enzymes whose usual inhabitants are the soil and are continuously playing an important role in maintaining soil ecology, physical and chemical properties, fertility, and soil health. These enzymes play key biochemical functions in the overall process of organic matter decomposition in the soil system. All soils contain a group of enzymes that determine soil metabolic processes which, in turn, depend on its physical, chemical, microbiological, and biochemical properties. Soil enzymes increase the reaction rate at which plant residues decompose and release plant available nutrients. The substance acted upon by a soil enzyme is called the substrate. The enzymatic reaction releases a product, which can be a nutrient contained in the substrate. Sources of soil enzymes include living and dead microbes, plant roots and residues, and soil animals. Enzymes stabilized in the soil matrix accumulate or form complexes with organic matter (humus), clay and humus-clay complexes, but are no longer associated with viable cells. It is thought that 40 to 60% of enzyme activity can come from stabilized enzymes, so activity does not necessarily correlate highly with microbial biomass or respiration. Therefore, enzyme activity is the cumulative effect of long term microbial activity and activity of the viable population at sampling.

However, an example of an enzyme that only reflects activity of viable cells is dehydrogenase, which in theory can only occur in viable cells and not in stabilized soil complexes.

Kind of soil enzyme

1. Constitutive

Always present in nearly constant amounts in a cell (not affected by addition of any particular substrate – genes always expressed).

(Pyrophosphatase)

2. Inducible

Present only in trace amounts or not at all, but quickly increases in concentration when its substrate is present.

(Amidase)

Both types of enzymes are present in the soil.

State of soil enzyme

State-1: Role of Clays

a. Most activity associated with clays.

b. Increases resistance to proteolysis and microbial attack

c. Increases the temperature of inactivation.

State-2 :Role of Organic Matter

a. Humus material provides stability to soil nitrogen compounds

b. Enzymes attached to insoluble organic matrices exhibit pH and temperature changes.

c. Inability to purify soil enzymes free of soil organic matter (bound to O.M.)

State-3: Role of O.M. - Clay Complex

a. Lignin + bentonite (clay) protect enzymes against proteolitic attack, but not bentonite alone.

b. Enzymes are bound to organic matter which is then bound to clay.

Importance of soil enzyme

Enzymes respond to soil management changes long before other soil quality indicator changes are detectable. They are important in catalyzing several vital reactions necessary for the life processes of micro-organisms in soils and the stabilization of soil structure, the decomposition of organic wastes, organic matter formation, and nutrient cycling, hence playing an important role in agriculture. Some enzymes only facilitate the breakdown of organic matter (e.g., hydrolase, glucosidase), while others are involved in nutrient mineralization (e.g., amidase, urease, phosphatase, sulfates). With the exception of phosphatase activity, there is no strong evidence that directly relates enzyme activity to nutrient availability or crop production. Sinsabaugh *et al*,. 1991

Table 1. Role of soil enzymes

Enzyme	**Organic Matter Substances Acted On**	**End Product**	**Significance**	**Predictor of Soil Function**
Beta glucosidase	carbon compounds	glucose (sugar)	energy for microorganisms	organic matter decomposition
FDA hydrolysis	organic matter	carbon and various nutrients	energy and nutrients for microorganisms, measure microbial biomass	organic matter decomposition nutrient cycling
Amidase	carbon and nitrogen compounds	ammonium (NH4)	plant available NH4	nutrient cycling
Urease	nitrogen (urea)	ammonia (NH3) and carbon dioxide (CO2)	plant available NH4	nutrient cycling
Phosphatase	phosphorus	phosphate (PO4)	plant available P	nutrient cycling
Sulfatase	sulfur	sulfate (SO4)	plant available S	nutrient cycling

The relationship may be indirect considering nutrient mineralization to plant available forms is accomplished with the contribution of enzyme activity. Enzymes respond to soil management changes long before other soil quality indicator changes are detectable.

1. Release of nutrients in soil by means of organic matter degradation

2. Identification of soils.
3. Identification of microbial activity.
4. Importance of soil enzymes as sensitive indicators of ecological change.

Application of soil enzyme

- ❖ Correlation with soil fertility
- ❖ Correlation with microbial activity
- ❖ Correlation with biochemical cycling of various elements in soil (C, N, S)
- ❖ Degree of pollution (heavy metals, SO4)
- ❖ To assess the successional stages of an ecosystem
- ❖ Rapid degradation of pesticides
- ❖ Disease studies
- ❖ Enzyme activity as biological indicator of soil health and quality and monitoring soil quality improvement

Soil enzymes as biological soil quality indicator

Soil Quality:

Capacity of a specific kind of soil to function within ecosystem and landuse boundaries, to sustain biological productivity, maintain environmental quality and sustain plant, animal and human health, Bandick and Dick, 1999.

Soil health:

A state of dynamic equilibrium between flora and fauna and their surrounding soil environment in which all the metabolic activities of the former proceed optimally without any hindrance, stress or impedance from the later, Dick, 1994.

The definition of soil quality encompasses physical, chemical and biological characteristics, and it is related to fertility and soil health.

Specific problems that might be caused by poor function: Absence or suppression of soil enzymes prevents or reduces processes that can affect plant nutrition. Poor enzyme activity (e.g., pesticide degrading enzymes) can result in an accumulation of chemicals that are harmful to the environment; some of these chemicals may further inhibit soil enzyme activity.

What you can do: Organic amendment applications, crop rotation, and cover crops have been shown to enhance enzyme activity (figures 1 and 2). The positive effect of pasture (figure 2) is associated with the input of animal manure and less soil disturbance. Agricultural methods that modify soil pH (e.g., liming) can also change enzyme activity.

i. Distributed or dissolved in soil solution.
ii. Adsorbed on soil clay surface.
iii. Adsorbed on soil organic polymers (humus).
iv. Partition in soil organic polymers (humus).
v. Polymerized to soil organic polymer (humus).
vi. Distributed in interlayers of clays.
vii. Distributed in cytoplasm of living organisms.
viii. Distributed in the periplasmic slime of living organisms.
ix. Distributed in residues of organisms (plant and animals).

Measuring soil enzymes: Enzymes are measured indirectly by determining their activity in the laboratory using biochemical assays. Enzyme assays reflect potential activity and do not

represent true in situ activity levels and must be viewed as an index. When possible, compare the site of interest to samples taken from an adjacent, undisturbed site on the same soil type. Alternatively, for a newly implemented land management system, track changes from time zero to five or more years with annual sampling to detect temporal changes in activity of soil enzymes, Tabatabai,1994.

Reference:

Bandick A.K. and Dick R.P. (1999). Field management effects on enzyme activities. Soil Biology and Biochemistry **31**:1471-1479

Dick R. P. (1994). Soil Enzyme Activity as an Indicator of Soil Quality. In: Doran J.W. *et al.,* editors. Defining soil quality for a sustainable environment.. Madison, WI. p107-124.

Sinsabaugh R. L, Antibus R. K., Linkins A. E. (1991). An enzymic approach to the analysis of microbial activity during plant litter decomposition. Agric Ecosyst Environ **34**:43–54

Tabatabai M. A. (1994). Soil Enzymes. In: Weaver RW et al., editors. Methods of soil analysis. Part 2. Microbiological and Biochemical Properties. p 775-833.