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Role of Soil Enzymes in Maintaining Soil Health

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Abstract

Soil enzymes are constantly playing vital roles for the maintenance of soil ecology and soil health. These enzymatic activities in the soil are mainly of microbial origin, being derived from intracellular, cell-associated or free enzymes. Therefore, microorganisms are acting as the indicators of soil health, as they have active effects on nutritional cycling, also affecting the physical and chemical properties of soil. Microorganisms respond quickly even to minute changes by changing their population and activities, and thus, can be used for soil health assessment. On the other hand, soil enzymes are the direct mediators for biological catabolism of soil organic and mineral components and they are often closely related to soil organic matters, soil physical properties, and microbial activities or biomass. They are the better indicators of soil health as changes of enzymes are much sooner than other parameters, thus providing early indications of changes in soil health. In addition, their activities can be used as the measures of microbial activity, soil productivity, and inhibiting effects of pollutants.

Introduction

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 chemicalproperties, fertility, and soil health. These enzymes play key biochemical functions in the overall process of organic matter decomposition in the soil system (Sinsabaugh *et al.*, 1991). 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, andnutrient cycling, hence playing an important role in agriculture. The enzyme levels in soil systems vary in amounts primarily due to the fact that each soil type has different amounts of organic matter content, composition, and activity of its living organisms.

Soil Health

Soil health can be defined as the continued capacity of soil to function as a vital living system, within the ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments, and maintain plant, animal, and human health (Doran and Zeiss, 2000).

Potential Roles of Soil Enzymes in Maintaining Soil Health

Amylase

- Starch hydrolyzing enzyme amylase is constituted by α-amylase and β-amylase.
- It plays a significant role in the breakdown of starch,

α-amylases converts starch like substrates to glucose and/ or oligosaccharides and β-amylase, which converts starch to maltose. These enzymes are playing vital role in decomposition of organic matter in soil.

β-Glucosidase

- This enzyme plays an important role in soils by catalyzing the hydrolysis and biodegradation of various β-glucosides present in plant debris decomposing in the ecosystem into glucose, which is a source of nutrient for many number of soil microorganisms (Martinez and Tabatabai, 1997). β-glucosidase is characteristically useful as a soil quality indicator, and may give a reflection of past biological activity, the capacity of soil to stabilize the soil organic matter, and can be used to detect management effect on soils.

Chitinases

- Chitinase or chitinolytic enzymes are key enzymes responsible for the degradation and hydrolysis of chitin. Chitin is the major structural component of many fungal cell walls. They cause the degradation of cell walls of pathogenic fungi. These enzymes are effectivein the control of soil-borne diseases such as *Sclerotium rolfsii* and *Rhizoctonia solani* in beans and cotton, respectively.

Dehydrogenases

- This enzyme exists as an integral part of intact cells but does not accumulate extracellularly in the soil. Dehydrogenase enzyme is known to oxidize soil organic matterby transferring protons and electrons from substrates to acceptors. These processes are the part of respiration pathways of soil microorganisms and are closely related to the typeof soil and soil air-water (Mambu, 2014). It may give indications of the potential of the soil to support biochemical processes, which are essential for maintaining soil fertility as well as soil health.
- After flooding the soil, the oxygen present is rapidly exhausted so that a shift of the activity from aerobic to anaerobic microorganisms takes place. Such redox transformations are closely connected with respiration activity of soil microorganisms. They may serve as indicators of the microbiological redox systems in soils and can be considered a possible measure of microbial oxidative activity.
- For instance, lack of oxygen may trigger facultative anaerobes to initiate metabolic processes involving dehydrogenase activities and the use of Fe (III) forms as terminal electron acceptors, a process that may affect iron availability to plants in the ecosystem.
- Dehydrogenase enzyme is often used as a measure of any disruption caused by pesticides, trace elements or management practices to the soil, as well as a direct measure of soil microbial activity. Higher activities of dehydrogenases have been reported at low doses of pesticides; and lower activities of the enzyme at higher doses of pesticides. Also indicate the type and significance of pollution in soils. For example, dehydrogenase enzyme is high in soils polluted with pulp and paper mill effluents, but low in soils polluted with fly ash.

Phosphatases

- Phosphatases are the group of enzymes hydrolyses the P from organic bound state into inorganic available forms as orthophosphates and thus play critical role in P cycle in soil (Nannipieri *et al.*, 2011). For example, when there is a signal indicating P deficiency in the soil, acid phosphatase secretion from plant roots is increased to enhance the solubilization and remobilization of phosphate, thus influencing the ability of the plant to cope with P-stressed conditions.

Ureases

- Urease enzyme is responsible for the hydrolysis of urea fertilizers applied to the soil into NH_3 and CO_2 with the concomitant rise in soil pH. This, in turn, results in a rapid N loss to the atmosphere through NH_3 volatilization, a process considered vital in the regulation of N supply to plants after urea fertilization. Soil urease originates mainly from plants and microorganisms found as both intra- and extra-cellular enzymes and are rapidly degraded in soil by proteolytic enzymes.

Conclusion

It is very essential to understand the possible roles of soil enzymes in order to maintain soil health and its fertility management in ecosystems. These enzymes, usually found in the soil, may have significant effects on soil biology, environmental management, growth and nutrient uptake in plants growing in ecosystems. Their activities may, however, be influenced by unknown cultural management practices either in a major or minor amount. Studies focusing the discovery of new enzymes from microbial diversity in the soil might be the most suitable practices that may positively influence their activities for improved plant growth as well as rendering the friendly biological environments in order to sustain other living beings.

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