Phosphodiesterase (PHD) Test Information Rev. 1.0

Ward Laboratories Inc.

Introduction

Plant available phosphorus (P) is dependent on the immobilization, adsorption and dissolution of P in the soil environment. As the second most limiting nutrient, P is often applied in standard fertilizer applications. Adequate P availability is important to support cell growth and stimulate early plant growth and maturity in crops. The mineralization and cycling of organic P in the soil is dependent on the activity of specific soil enzymes, known collectively as phosphatases, to transform organic P to plant available P. Without the activity of phosphatases, a substantial proportion of P would be immobile or structurally unavailable to plants and soil microbes. Phosphatases act on organic P within the soil in addition to commonly applied fertilizers, such as manure, to form free phosphates (PO_4^{3-}) available for plants and soil microbiology.

Phosphodiesterase (PHD) is a phosphatase responsible for the degradation of nucleic acids, phospholipids and other diesters in the soil. When fresh organic P enters the soil, phosphodiesterase acts as the initial responder and cleaves the large compounds into smaller, easily accessible molecules (See Figure 1). Depending on the soil pH, alkaline or acid phosphomonoesterase enzymes further reduce the molecule to free phosphates. Thus, PHD activity is tightly linked to soil organic P cycling in the soil. In addition, PHD activity is often higher in the rhizosphere than in bulk soil, suggesting a significant role of phosphodiesterase in plant P acquisition.

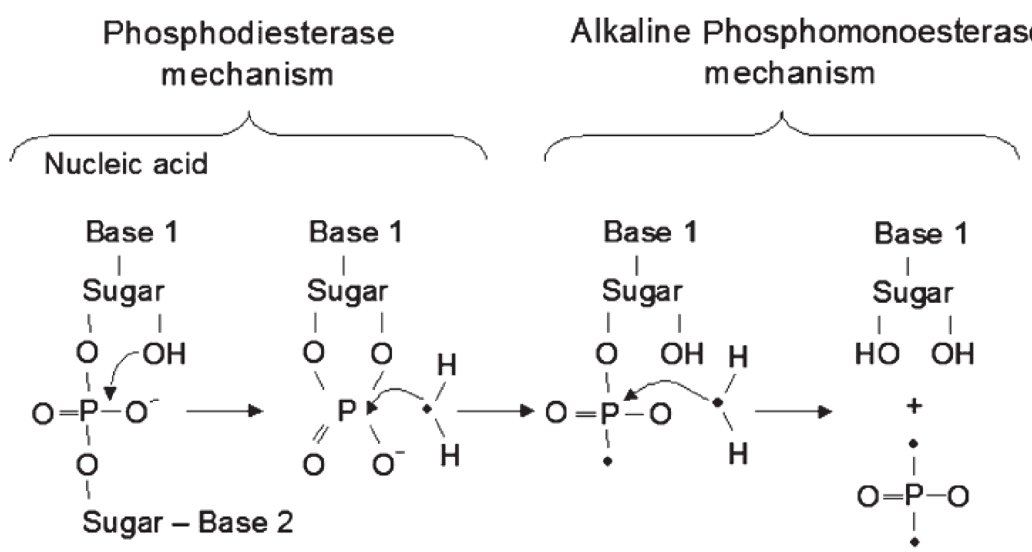

Figure 1: The action of phophodiesterase and alkaline phosphomonoesterase to release phosphates
(Image from Nannipieri 2011)

Soil enzyme testing at Ward Laboratories is conducted by analyzing the consumption of a substrate and the release of a colored product. The consumption of product is measured over time and results are expressed as a rate of enzyme activity. By using controlled soil conditions (e.g. pH, temperature), the enzyme activity rates can indicate the potential activity for the soil enzymes under ideal conditions. This allows a comparison of potential enzyme activities between different soil management practices. Similarly, the same site can be tracked over time to monitor subtle changes in microbial dynamics and provide an indication of the microbial community response to changing environmental conditions and management.

Procedure Outline

Soil samples received by the laboratory should be cooled and in field moist condition. Each soil sample is passed through a 2 mm sieve and weighed into two centrifuge tubes (1.00 ± 0.05 g each). The first subsample is referred to as the treatment sample and the second subsample is referred to as the control sample. Each vial receives 4 mL buffer solution. The treatment vial receives 1 mL substrate prior to all samples being incubated for 1 h at 37°C. After incubation, the control vial receives 1 mL substrate. All vials receive 4 mL stop buffer and 2 mL flocculant. Vials are centrifuged, filtered with Whatman 2V filter paper and analyzed on a spectrophotometer at 405 nm. Enzyme activity is expressed as ppm *p*-nitrophenol g^{-1} dry weight soil h^{-1}.

Interpretation of soil enzyme activity requires an understanding of nutrient or organic matter cycling. Often, healthy, active systems have increased enzyme activity, relating to better cycling of nutrients and organic matter quality in the soil. Nevertheless, sites with recent disturbances may have higher activity levels due to increased substrate availability when compared to non-disturbed sites. For example, a conventional tillage field versus a no-till field in its first year of transition may indicate the tilled field has higher enzyme activity. This is because the act of tilling a field provides aeration and better distribution of substrates to microbes. The increased activity cannot be fully sustained in this system and often causes the enzymes to access the nutrients in organic matter, leading to a loss of organic matter the following year. A list of common soil characteristics and soil management impacts can also be found in the interpretation guide.

Additional information will be added to the website as new information becomes available. Any questions regarding soil enzyme testing may be directed biotesting@wardlab.com.