

Anion Storage Capacity (Phosphate Retention test)

Phosphate retention is an empirical measure of the ability of a soil to remove phosphorus from the soil solution, generally in the form of phosphate, and retain or adsorb the phosphate on the soil colloid surfaces.

This adsorbed phosphate so adsorbed is in dynamic equilibrium with soil solution phosphate and is not irreversibly bound to the soil. As plants and soil fauna and flora remove phosphate ions from soil solution, phosphate is desorbed from the colloid surfaces to replenish the plant available (soil solution) phosphate. In this way, the soil colloids 'store' phosphate for the continued phosphate nutrition of plants throughout the year or growing season. If soils did not have the ability to store phosphate, phosphate fertilisers would need to be applied several times through the growing season

Occluded phosphate

A second and continuing but much slower process of phosphate fixation also occurs in soils, which renders phosphorus unavailable to plants. Some of the phosphate on the soil colloids diffuses into certain clay minerals such as allophane and becomes part of the soil, while in certain conditions metal oxide coatings can form over the outside of soil colloids trapping the phosphate and other surface bound nutrients under this coating, a process called occlusion.

Measurement of ASC

Iron and/or aluminium oxides in the soil is the major soil property determining phosphate retention. Allophane and ferrihydrite are the compounds associated with phosphate retention and therefore soils with large amounts of allophane and ferrihydrite may show very high retention values. The method of analysis was designed to give a good differentiation between low and high phosphorus retaining soils, and to help advisors to assess P fertiliser requirements.

ASC is determined using a buffered solution at pH 4.6, containing 1000mg/L phosphorus. This method was

designed to reflect maximum phosphate retention that are for most soils achievable at a pH of 4.6. The difference in initial 1000 mg/L phosphorus added and the phosphorus remaining after 16 hours of shaking is used to calculate the % ASC.

Importance

Phosphate retention is an inherent property of the soil and does not change so it is necessary to only test a particular block once. More recently, AgResearch changed the name of the test from phosphate retention to Anion Storage Capacity (ASC) in an effort to get away from the negative connotation that is implied by the term retention, and this also makes the test analogous to the cation storage capacity (CEC) test. This is an important factor in determining how much P fertiliser will be available to the plant and how much P fertiliser is required to raise soil test levels to target values. Most fertiliser advice takes account of this. Plant response to plant available P as reflected by Olsen P test results is not affected by ASC (Reid et al., 2020).

Volcanic ash soils have high phosphate retention's (>80%), pumice soils medium values (50-80%), with sedimentary soils (30-60%) and most peats, podzols and coarse textured soils (<20%) having much lower values. The higher the phosphate retention the more phosphate is required to overcome a phosphate deficiency and/or maintain soil phosphate levels.

Fertiliser choice and the environment

Rapid leaching of mobile anions, for example, sulphate will occur in soils with very low ASC (<20%). Therefore, the ASC figure can also be used as a guide to the forms of S fertiliser to use. P losses through drainage are largely determined by the P sorption capacity of the soil resulting in greater losses from soils with low ASC compared to higher ASC soils. Moderating fertilizer application rates and use of less soluble fertilisers are strategies to minimise environmental impacts on low ASC soils.

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