ANION STORAGE CAPACITY (PHOSPHATE RETENTION)

Phosphate Retention (PR) is a measure used to describe the phosphorus (P) immobilisation potential of a soil. The term Anion Storage Capacity (ASC) is the modern term for this feature of soil science – adopted because similar effects are seen with sulphur (S) as another essential plant nutrient. An ASC test should be included with any initial soil test to establish the level for the sampled area and is useful information when considering phosphorus and sulphur fertilisers. For simplicity, the term ASC will be used in this technical note, but the same information applies equally to PR.

The conventional ASC (PR) test is expressed as the percentage of phosphorus that is removed from a solution of 1000ppm P by the soil after shaking at pH 4.6, when the soil will show maximum phosphate fixation. Soil ASC is categorised as high (>60%), medium (30 to 60%) or low (<30%). This level is an inherent property of the soil and does not change.

It is important to understand that an ASC of 90% does not mean that 90% of applied P fertiliser is rendered unavailable to plants.

Research work has shown that high ASC soils may require as much as two times the amount of phosphorus as capital or maintenance fertiliser than low ASC soils. Sulphate-S is subject to leaching loss from low ASC soils, in contrast with high ASC soils that tend to accumulate sulphate-S.

The variation in ASC between soil types is related to the amounts of specific iron and aluminium compounds and the type of clay minerals in the soils. This is determined by the type of rock or parent material that the soil has developed from. For example, soils developed from volcanic ash tend to have high ASC; soils developed from greywacke alluvium tend to have low ASC.

Typical ASC/PR levels

Level	ASC/Phosphate Retention (%)	Soil Types
Very Low	< 10	e.g. raw peats, some sedimentary soils (e.g. pallic soils, sands)
Low	10 - 30	
Medium	30 - 60	e.g. pumices, developed peats, sedimentary soils, some ash soils
High	60 - 80	
Very High	> 80	e.g. allophanic ash soils

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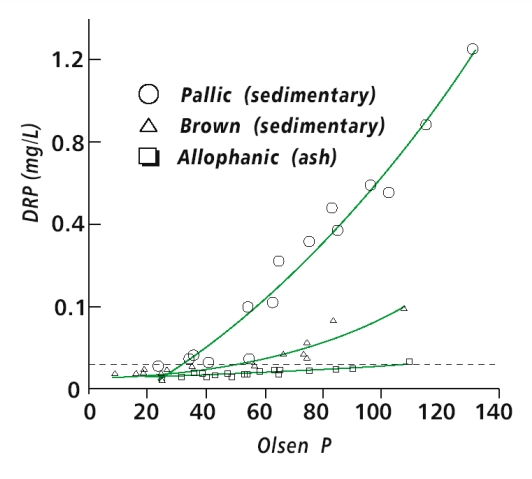
ASC by NIRS

Near infra-red spectroscopy (NIRS) has been used at Hill Laboratories for many years to measure a range of soil constituents, particularly those associated with the organic fraction in soil. A successful calibration for ASC has now also been constructed (May,2017). Correlation studies between ASC by NIRS and the reference chemistry method showed very good relationships, and NIRS also gave superior performance over the ASC(estimated) method previously in use by Hill Laboratories. Measuring ASC using the NIRS technique will be the standard method for this test from mid-2017. The laboratory will continue to monitor the standard error of prediction for each ASC(NIRS) result in real-time and, when needed, "code-swap" to the reference method. The method text on each result report describes the technique used for that test for every sample.

P Loss Risk

Loss of phosphorus from land to water usually occurs from surface flow (rather than leaching) and the risk is higher for low ASC soils than for high ASC soils as shown in Fig 1. Forms of P fertiliser as well as application rates for different ASC soils should therefore be considered in high risk situations.

- P concentrations in overland flow increase as soil Olsen P levels increase, especially in soils with anion storage capacity (ASC) less than 20%, where less P is bound to clay particles. This is shown in the graph below:



On the low ASC (15%) pallic soil the concentration of DRP (Dissolved Reactive Phosphorus) was greater than the guideline of 0.03 mg/L for surface water quality where soil fertility exceeded Olsen P 30, the upper end of the target range for sedimentary soils (see p 26). For the higher ASC brown (49%) and allophanic (ash - 83%) soil, DRP concentrations above the guidelines were achieved at much higher Olsen P levels (50 and 110 respectively).

Fig 1. Extract from "Loss of P from land to water", Fertiliser Use on New Zealand Dairy Farms Handbook, NZFMRA 2009, p17.

References

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2. Saunders, W.M.H. (1965). Phosphate retention in New Zealand soils and it's relation to free sesquioxides, organic matter and other soil properties. New Zealand Journal of Agricultural Research. 8:30.
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