

Optimal use of phosphorus in cereals under Nordic conditions

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The phosphorus (P) fertilizer recommendations in Norway are based on a balanced P application strategy. This implies adding the same amount of P as that removed by the yield at an optimum soil P-level. The recommendations were adjusted in 2007. Until then a surplus of P was recommended, based on assumptions of P adsorption in the soil. Over many years this strategy led to increasing amounts of plant available P in soil, which in some cases was undesirable for environmental reasons.

The amount of P removed in grain is determined by the yield level and the concentration of P in its dry matter (DM). The P concentration in grain varies from year to year and site to site, but 0.4 % P was selected as an average value. A yield of 4 Mg grain ha⁻¹ thus removes 14 kg P ha⁻¹. If straw is also removed, it is recommended to increase the amount of P fertilizer by 3.5 kg P ha⁻¹.

To estimate the amount of plant available P in soil, the P-AL method (Egner *et al.* 1960) is used as the standard test for agricultural soils. In 2007 a new system was introduced to adjust P recommendations according to the P-AL level. P-AL 5-7 is now defined as an optimal level, at which a balanced P fertilizer strategy is recommended. Where the soil P level is below this, it is recommended to apply more than the P-balance, in order to raise the P-AL level. Where the soil P-AL level is above the optimal level, it is recommended to decrease P fertilization. A linear decline is adopted, reaching zero P application at P-AL 14. Above this level, the soil is expected to supply crops with sufficient plant available P.

The new correction system has a stronger reduction in P fertilization than before at high to very high P-AL levels, with the aim of a faster lowering of P-AL in such cases. It is expected that the new P fertilizer norm and new correction system will reduce P fertilizer use in cereals by around 50 %. Statistics on fertilizer use confirm that farmers on the whole follow the new recommendations. It will nevertheless take many years before there will be a significant reduction in the P-AL levels in agricultural soils in Norway.

In Norway band placement of compound fertilizer is recommended. Favourable placement of P in relation to plant roots enables plants to make better use of the applied fertilizer. The use of starter fertilizer is also recommended on silty soils, where root growth or nutrient uptake is often limited during the first weeks after sowing due to low soil temperature. Starter fertilizer means placing some P (and N) in the immediate vicinity of the seed.

Field trials and pot experiments have recently been conducted to examine crop responses to P fertilization relative to the soil's P-AL value. The results show that the responses decrease with increasing P-AL level, and confirm the soil's ability to supply plants with sufficient P when P-AL is above 14.

More research is going on to further improve the interpretation of P-AL values. The soil's adsorption capacity plays an important role in controlling the amount of plant available P, and this topic is being studied at present. Better utilization of P from organic fertilizer sources, in order to further reduce the use of mineral P, is also a future challenge.