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A simple model of P uptake by crops as a possible basis for P fertilizer recommendations

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Abstract

In the Netherlands the Pw value, based on an extraction of soil P with water, is used as a basis for P-fertilizer recommendations for arable crops. Using a simple, mechanistic model of P transport in the soil the Pw value required for adequate P uptake by crops can be calculated on the basis of daily uptake requirements, root area index, P-adsorption isotherms and total amount of P taken up during a growing season. Calculated Pw values for adequate uptake are in the same range as the present recommendation scheme based on field experiments. Possible refinements of the model are discussed. For each soil the Pw value can be calculated that corresponds to the P concentrations in the soil solution according to standards set to reduce environmental pollution. Our model predicts that, unless the root area index of non-cereal crops is considerably improved, these standards cannot be met in the plough layer without affecting crop production levels. Calculations show that the present method of determining the Pw value yields a reasonable compromise between a measurement of intensity and capacity of P supply in the soil.

Keywords: root length density, root area index, phosphorus availability, phosphate adsorption, barley, bean, maize, onion, potato, sugar beet, wheat

Introduction

The major aim in soil fertility research in the Netherlands in the past century has been to raise existing soil fertility levels to the point where nutrient supply is non-limiting. Increasing the phosphorus supply was one of the first priorities in N.W. Europe, and still is in many tropical countries. The first question, still relevant, was at what soil fertility level supply is non-limiting. In our present definition this is the level where, per unit root, the supply is equal to demand throughout the growing season. The critical level thus depends on plant factors that affect total demand, on the size of the root system, and on soil factors determining supply.

For a fertilizer recommendation scheme we also need to know how serious growth reductions are at soil fertility levels slightly below the critical level and what the relative effectiveness of various soil amendments (e.g. manure, cattle slurry) is. Furthermore, current fertilizer recommendation schemes are based on fertilizer/product