Legacy P workshop – APEX

Mineral P

The APEX approach is based on a partitioning concept originally developed to partition pesticides into the solution and sediment phases (Knisel, 1980). The P mineralization model developed by Jones et al. (1984) is a modification (Williams, 1995) of the Production of Arid Pastures Limited by Rainfall and Nitrogen (PAPRAN) mineralization model (Seligman and van Keulen, 1981). Mineral P is transferred among three pools: labile, active mineral, and stable mineral. The flow between the labile and active mineral pools is governed by an equilibrium equation that considers the amount of P in the labile and mineral active pool, and the P sorption coefficient. The P sorption coefficient is a function of chemical and physical soil properties (i.e., $CaCO_3$ concentration, pH, clay content, and base saturation). The flow between mineral pools is governed by the amount of P in the active and stable pool, and by a flow coefficient which is affected by the P sorption coefficient and by the $CaCO_3$ concentration.

Organic P

Mineralization from the fresh organic P pool is estimated for two sources of organic P: the fresh organic P, associated with crop residues and microbial biomass, and the stable organic P, associated with the soil humus. The mineralization from the fresh organic P pool is the product of the mineralization rate constant and the fresh organic P content. Mineralization of organic P associated with hummus is estimated as a function of soil water content, temperature, and bulk density. P mineralization is calculated as a ratio to N mineralization.

The P immobilization model was also developed by Jones et al. (1984). The daily amount of immobilization is computed by subtracting the amount of P contained in the crop residue from the amount assimilated by the microorganisms.

Plant P uptake

Crop P uptake is simulated with a supply-demand approach. Mineral P is made available for crop uptake from each layer within the defined root depth. The daily crop P demand is the difference between the crop P content and the ideal P content for that day.

Surface P losses

The APEX approach is based on the concept of partitioning phosphorus into the solution and sediment phases as described by Leonard and Wauchope (Knisel, 1980). Soluble P can be estimated using the GLEAMS linear equation or using the Langmuir approach. The GLEAMS approach considers the amount of runoff and the available mineral labile P. The Langmuir approach considers the runoff volume, the amount of mineral labile P available, the soil clay content, and a P adsorption coefficient. Soluble P runoff from manure is estimated considering the amount of mineral labile P in manure in the first soil layer and the runoff volume.

Sediment transport of P is simulated with a loading function that considers the amount of sediment and the organic P concentration in the top soil layer. If manure is present, organic P derived from manure erosion is added to the fraction transported with sediment.

Subsurface P losses

The mineral P lost with water percolation includes the fraction that comes from mineral P and the fraction that comes from manure. The percolation from the mineral P can be estimated using the GLEAMS or Langmuir approach. Both approaches consider the amount of percolating water, the labile P available, the soil clay content, and a parameter for the soluble P leaching. There are separate coefficients, one for the top soil layer and one for all other layers. Recently, the model was modified to allow the variation of this parameter during the simulation according to the fertilizer placement (surface application *vs* incorporated) and tillage operation. Like for the P lost from the mineral fraction, the amount of mineral P percolated from manure is estimated considering the amount of percolating water, the amount of mineral P in manure, the soil clay content, and a parameter for the soluble P leaching. The calculation is done for each soil layer.

The fraction lost in the quick return flow is calculated considering the fraction of quick return flow over the total subsurface flow, the amount of labile P available, the clay content, and a parameter for the soluble P transport that is affected by the placement of fertilizer and tillage operations. The horizontal P flow can be calculated using the GLEAMS or Langmuir approach.

The fraction of P lost in the drainage system is calculated as normal losses in the quick return flow but assigned to a loss in the drainage system if the P loss occurs in a soil layer with a drainage system.

P outflow from reservoir and ponds

It is calculated considering the concentration of P in sediment in the reservoir or pond, the amount of sediment in the reservoir or pond (so the concentration can be calculated), and the amount of water released from the reservoir or that comes out of the pond. The amount of sediment in the reservoir or pond is updated daily considering the amount of sediment that comes into the reservoir or pond from the upland subareas.

Cited bibliography

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