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Role of dispersivity length in pesticide-leaching modeling

Aleksandra Belik (1,2)

(1) Lomonosov Moscow State University, Moscow, Russia (belikalexandra@gmail.com), (2) All-Russian Scientific Research Institute of Phytopathology, Bolshie Vyazemy, Moscow reg., Russia

Pesticides management is impossible without understanding principles of substances migration with water flows in soils. The soil pore space has a complex structure with moisture-conducting paths of various sizes and shapes, it determines the specificity of water movement mechanisms and introduces uncertainty into modeling process. It is possible to reduce uncertainty and improve prediction accuracy by the dispersivity length (DL - coefficient, taking into account hydrodynamic dispersion and pore water velocity). The basic method of its experimental determination is a laboratory filtration experiment in soil columns and subsequent solution of inverse problems (CFITIM model). But influence of scale, lack of horizontal water transfer and other factors lead to differences between water movement under experimental and real conditions. Therefore, we proposed field determination of DL, based on observing of the tracer movement. The aim of our work was to compare the dispersivity lengths, obtained in laboratory and field experiments, using pesticide-leaching modeling.
The nudiargic glossic albic retisol was chosen for the experiments, it's typical soil for Moscow region and has prefenitial flows. In the laboratory experiment we determined the DL for undisturbed soil monoliths (h=10 cm, d=4.5 cm), which was successfully taken from the various depths (0, 5, 20, 40 and 60 cm). The DLs increased with depth and were 5; 3.5, 7; 7.5, 13 and 19 cm. In the field experiment Brilliant Blue Food Colors Dyes was used as a tracer, which has good reproducibility of the migration paths in soil. Tubes, filled with aqueous solution of the tracer (h=10 cm, d=4.5 cm), were installed at the pre-saturated site of soil (at depths of 0, 5, 20, 40 and 60 cm). After filtration, vertical cuts were made along the edges and at the center of tubes, and analysis of the tracer distribution was conducted. The DL was determined as difference between the average line of the mass tracer displacement and the boundaries of infiltration streams. The experiment was carried out in triplicate, median values were calculated. For the surface and at 5 cm depth fronts of tracer movement were continuous with well-defined boundaries, the DLs were 4 and 2 cm respectively, front was blurred with increasing depth, boundary became tongued. For the site at depth of 20 cm the DL was 12 cm, at 40 cm - 9 cm, deeper 60 cm - more than 20 cm.
To assess the effect of DL on pesticides migration in soil we have compared experimental and predicted pesticide concentrations (6 time points), calculated by PEARL4 model with following DLs: 5 cm (recommended in the model manual), experimental laboratory and field values. Based on the analysis NRMSE predictions with laboratory and 5 cm DLs were very close. While model with field DL better described the behavior of pesticide, especially in lower layers, reducing the NRMSE, for example, for 10-15 cm layer from 0.75 to 0.57.
The field method allows to reproduce pesticides migration with sufficient accuracy, taking into account the variation in the soil pore space.