SIMULATING SOIL AND GROUNDWATER CONTAMINATION BY COPPER AND MANGANESE FROM AGRICULTURAL FUNGICIDES

BY

JIMMY AKINFEMI OSUNBITAN
(B.Sc., M.Sc. Agricultural Engineering, R. Eng. (COREN))

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ABSTRACT

This work developed predictive models that simulated the transportation of copper and manganese from agricultural fungicides through the soil profile as well as the adsorption of the metals to the soil particles.

The experiment was conducted in two stages and these stages were Batch Equilibrium Test (BET) and Soil leaching experiment. The BET was conducted as 2 x 4 x 6 factorial experiment. The variables were soil types (Egbeda and Apomu), pH and fungicide concentration. The leaching experiment was conducted as 2 x 3 factorial experiments. The variables were soil type (Egbeda and Apomu) and fungicide concentration. For Batch Equilibrium test, air-dried soil sample of about 1 g was equilibrated with 10 ml solution containing the desired concentrations of the fungicide in a centrifuge. After equilibration and centrifugation, the supernatant were analysed for copper and manganese using Atomic Absorption Spectrophotometer (AAS). Absorption was then estimated from the decrease in the concentration of the metals in the fungicide in the liquid phase after equilibration. For the column leaching experiment, soil columns were wetted at the rate of about 5 mm/h for 1 day. After saturation, the fungicides were applied and the columns kept completely saturated with water by maintaining ponding through continuous application of de – ionized water at a rate of about 10 mm/hr for the duration of the experiment. Leachate samples were collected every 6 hours for 7 days and the leachate analysed for copper and manganese using AAS. Data were analysed using descriptive and inferential statistics. Data from the BET and column leaching experiment were used to modify and validate relevant models.

The result of the BET showed that the equilibrium metal concentrations in the soil solution increased significantly with increasing metal concentration in the solution ($P < 0.05$). The solution pH was significant ($P < 0.05$) in its effect on the amount of metals adsorbed into the soil and the two soils were also significantly different ($P < 0.05$) in their adsorption capacity. The adsorbed metal increased with increase in solution pH and metal concentration with the maximum adsorption capacities at pH 6 and metal concentrations of 4.50 *g/l* and 1.44 *g/l* for Copper and Manganese respectively. Adsorption of copper into Egbeda and Apomu soils was best explained with Langmuir equation with $r^2 = 0.99$ and 0.97 respectively while Freudlich equation was the best model that explained the adsorption of manganese to the two soil types ($r^2 = 0.95$). The results of the leachate experiment showed that the factors considered were all significant ($P < 0.05$) in their effects on the concentration of the metals in the leachate. Furthermore, the result showed that the developed model was able to simulate the relative metal concentrations in the leachate. The r^2 ranges for Copper and Manganese were 0.95 to 0.99 and 0.71 to 0.98 respectively. The estimated values of the solute velocity and dispersion coefficient were also within the 95% Confidence Interval of the breakthrough curves estimates.

The study concluded that the developed model predicted well the fate of the metals in the soil - water environment when fungicides are applied to the soil.