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不同pH值和离子强度下土壤Zn2+/Cd2+/NH4+的运移特征

Characteristic of Zn2+/Cd2+/NH4+ transport in soils with different pH value and ionic strength

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中文关键词：土壤,离子强度,重金属,锌,镉,铵态氮,pH值,运移,出流时间,出流峰值

英文关键词:soils ironic strength heavy metal Zn Cd NH4+ pH value transport flow time peak value

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中文摘要:

为探究锌、镉及铵态氮在土壤中的运移特征，该文通过室内土柱混合置换试验，分析了不同pH值和离子强度对锌、镉、铵态氮（Zn2+、Cd2+、NH4+）在土壤中运移的影响；获得了示踪剂Br和Zn2+/Cd2+/NH4+的穿透曲线（breakthrough curves，BTCs），并对试验结果进行了模拟。研究表明：Zn2+/Cd2+/NH4+在土壤中运移时，运移速度：NH4+＞Zn2+＞Cd2+，pH值越高，Zn2+/Cd2+/NH4+的出流时间越晚，峰值越低；离子强度越大，出流时间越早，峰值越高。描述溶质运移的非平衡两点模型（two-site model，TSM）能够较好地模拟Zn2+/Cd2+/NH4+在土壤中的运移，pH值越高，模拟得到的分配系数Kd值越大（以Zn2+为例，由3.853增大到4.386），f值越小（以Zn2+为例，由0.231减小到0.006），分形系数β值很小且无明显变化规律；离子强度越大，模拟得到的分配系数Kd值越小（以Zn2+为例，由4.023减小到到3.381），f值及分形系数β值均很小且无明显变化规律。该研究对深入了解Zn2+/Cd2+/NH4+在土壤中的运移机理、提出污染土壤修复措施提供科学依据。

英文摘要:

Abstract: In order to make a thorough inquiry of Zn, Cd, NH4+ transportation in soils, the effect of pH and ionic strength on Zn, Cd, NH4+ transport in soils were studied, through a stable flow miscible displacement experiment. Breakthrough curves (BTCs) of the tracer bromide (Br) and Zn2+/Cd2+/NH4+ were obtained in these soil column experiments. With the software HYDRUS-1D, the local equilibrium assumption (LEA) model was used to simulate the observed BTCs of Br. Then we estimated the porosity θ and dispersion coefficient D and got the soil column migration model parameters. Through adjusting the value of Kd, β, α, f, two-site model (TSM) was used to simulate the BTCs of Zn2+/Cd2+/NH4+ with software HYDRUS-1D. Based on the analysis of BTCs observation, it turned out that transport velocity of Zn2+/Cd2+/NH4+ is NH4+＞Zn2+＞Cd2+ when they coexisted in migration. The higher the pH is, the later the flow time of Zn2+/Cd2+/NH4+ is, and the lower peak value of relative concentration is. The flow time of NH4+ was delayed by 8.08 pv to 9.72 pv and the peak value of the relative concentration dropped from 0.976 to 0.904. The flow time of Zn2+was delayed by 12.89 pv to 15.45pv and the peak value of BTCs dropped from 0.548 to 0.448. The flow time of Cd2+ was delayed by 13.32pv to 16.44pv and the peak value of the relative concentration dropped from 0.315 to 0.235. So the rise of pH can increase the adsorption quantity of Zn2+/Cd2+/NH4+ in soil and consequently block their transportation. On the other hand, the bigger the ionic strength is, the earlier the flow time of Zn2+/Cd2+/NH4+ is, and the higher the peak value is. The flow time of NH4+ was advanced from 8.78 pv to 7.68 pv and the peak value of the relative concentration rose from 0.933 to 1.013. The flow time of Zn2+ was advanced from 14.83 pv to 13.98 pv and the peak value of relative concentration rose from 0.496 to 0.542. The flow time of Cd2+ was advanced from 15.86 pv to 14.69 pv and the peak value of relative concentration rose from 0.281 to 0.294. Thus, the increase of ionic strength can decrease the adsorption quantity of Zn2+/Cd2+/NH4+ in soil and thereby promote their transportation. The non-equilibrium theory which describes a solute transport based two-site model described better transport of Zn2+/Cd2+/NH4+ in soils of this experiment. The higher the pH was, the bigger the partition coefficient Kd obtained through simulation was (taking Zn2+ for example, Kd was advanced from 3.853 to 4.386), the smaller f was (taking Zn2+ for example, f rose from 0.231 to 0.006), and fractal coefficient β was small and had no obvious change rule. The bigger the ionic strength was, the smaller the partition coefficient Kd obtained through simulation was (taking Zn2+ for example, Kd rose from 4.023 to 3.381), f and fractal coefficient β was very small and had no obvious change rule. The study has an important significance for heavy metals and the migration behavior of nitrogen in the soil and risk assessment, and pollution repair.

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