Modeling Hydrolysis of Selected Neonicotinoid Insecticides

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Abstract:
Occurrence of commonly used neonicotinoid insecticides such as Dinotefuran (DNT), Imidacloprid (IMD), and Thiamethoxam (THM) in the environment is a cause of concern due to their potential toxicity to non-target species. In this study, hydrolysis of these insecticides is modeled using pseudo-first order reaction rate kinetics. Hydrolysis rate constants for these insecticides at acidic, neutral and basic pHs were obtained after an extensive literature review. A net hydrolysis rate constant was calculated by taking into account the hydrolysis rate constants at acidic, neutral, and, basic pHs. The analysis of data obtained from the literature, clearly shows that among the neonicotinoids investigated, THM exhibits rapid hydrolysis compared to both IMD and DNT. Furthermore, hydrolysis under basic conditions was much faster compared to the neutral and acidic conditions. Net pseudo first-order hydrolysis rate for IMD and THM was found to be 0.037 d-1, and 0.01 d-1 respectively. Temperature has a pronounced effect on net hydrolysis rate of both IMD and THM. Modeled hydrolysis rate kinetics of neonicotinoids demonstrates that at 2<pH<11 hydrolysis rate was stable and dominated by rate constant at neutral pH whereas, beyond this pH range significant increase in hydrolysis rate was observed. Our results indicate that hydrolysis behavior of IMD and THM can be modeled by using pseudo-first order rate kinetics.