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The rhizosphere priming effect explained by microscale interactions among enzyme producing microbes

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Addition of small amounts of labile carbon (C), for example by root exudations, have been found to accelerate soil organic matter decomposition ('Priming Effect'). Possible explanations that have been suggested so far are that this C increases microbial turnover or - by increasing nitrogen (N) limitation of microbes - triggers increased mining of microbes for nutrients. Individual-based modeling of microbes at the microscale offer a new and alternative explanation for the emergence of the priming effect: Enzyme producing microbes benefit from proximity to other enzyme producing microbes since this increases their return of investment for each enzyme produced. The benefit grows the more microbes are close to each other, such that growth of a patch of microbes becomes a self-enhancing process. Our results show that there is a 'tipping point' – a critical size of such a patch, or number of spatially related microbes, which is necessary to start this process. In a model setting where soil microbes are C limited and thus only grow slowly, the addition of a small amount of labile C in a certain area is sufficient to trigger the emergence of such a growing microbial patch which consequently increases long-term decomposition rates of soil organic matter far beyond the initial labile C input in the model.