

Interactive comment on “Stoichiometry constrains microbial response to root exudation – insights from a model and a field experiment in a temperate forest” by J. E. Drake et al.

Anonymous Referee #1

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General comment

Drake et al. present a study on the role of plant exudates and their elemental composition (C and N) on growth and activities of microorganisms living into plant rhizosphere. Microbial activities are characterized by measurement of microbial respiration and enzymatic activities involved in the degradation of labile and recalcitrant organic matters. For their study they adopted an elegant approach combining theoretical modeling and experimental test in field conditions. Their results point on the importance of stoichiometric constrains of rhizosphere micro-organisms and show that the simultaneous exudation of C and N in rhizosphere triggers a larger stimulation of microbial activities

C2784

and growth than the exudation of C compounds alone. This microbial stimulation may then release N from SOM for plant uptake. Thus, these results can partly explain (from a life strategy point of view) why plants generally exude some N-rich compounds (like amino acids) though they are often N-limited. Thus, these findings are timely and of interest for communities of ecologists and biogeochemists. That being said I have also got some important reserves on the experimental plan, results and their interpretation. First, the experimental plan lacks of a +N control. Thus, it is possible to know whether the impact of “C + N treatment” on microbial activities is due to the delivery of N or both elements (C and N). The delivery of N alone could explain the observed decrease in activity of enzymes involved in decomposition of recalcitrant SOM (i.e. Bowden et al., 2004; Sierra and Nygren, 2005; van Groenigen et al., 2006) and the observed stimulation of microbial growth and activity of enzymes involved in decomposition of labile OM (see the prolific literature on N limitation of soil decomposers). The problem of lack of N control should at least be discussed. Second, authors only discuss the idea that soil microorganisms needs C AND N to growth and secrete enzymes (that is, stoichiometric constrains of microorganisms) signifying that the delivery of N in rhizosphere by plants is essential for an efficient stimulation of rhizosphere microorganisms that could mineralize soil organic nitrogen releasing soluble N for plants. However, there are numerous studies that also show that low nutrient availability favors microbial mining of N in recalcitrant SOM (i.e. Fontaine et al 2004, Carney et al, 2007). These studies appear to be in contradiction with your model and experimental results, but it might be not the case. Try to reconcile these results by proposing a “global theory” in the discussion section; for example it is possible soil microorganisms need a minimum N availability for growing and producing enzymes, which you could explain your results. However, when nutrient availability exceeds a threshold the supplemental delivery suppresses the mining activity of soil microorganisms and stimulates microbial communities that do not degrade SOM (Fontaine et al., 2003). Concerning the writing, the discussion section of the manuscript is clearer than the abstract and introduction section. Try to re-inject some sentences from the discussion to the introduction and abstract to better

C2785

present your ideas. For example, line 5 in abstract what do you mean by “the causal role of exudation”? I guess what you mean but the redaction should be improved to be clear (i.e. disentangle rhizosphere processes, isolate exudation effect). Line 13-15 in abstract: this part is important and should be limpid since you are presenting the two main hypotheses of your manuscript. What do you mean by “exudation alone”? Here it seems that the objective of your manuscript is to isolate the effect of exudation from effects of other rhizosphere processes, but you do not even mention these other processes and you do not explain how do you isolate specifically the exudation effect. Some sentences of the manuscript seem banal. For example at the end of abstract “This study supports a cause-and-effect relationship between root exudation and enhanced microbial activity...”. Really I think that your manuscript contains more important messages than this and that nobody doubts on the cause-and-effect relationship between root exudation and enhanced microbial activity in rhizosphere.

Specific points

P6903 L1-7 and in other parts of the manuscript where you present your two hypotheses. Presentation of first hypothesis is not clear: what do you mean by “exudation alone”. I am not sure that you isolated the effect of exudation from effect of other rhizosphere processes since exudate mimics were applied into plant rhizosphere where the other rhizosphere processes can proceed as well (which was a good idea from my opinion). Still in the presentation of first hypothesis: what do you mean exactly when you mention “exudate mimics”? Do these exudate mimics include C only or C and N ? It is not clear. P6905 Indication of soil pH is useful. P6906 Could you indicate whether microlysimeters were inserted in a soil zone where tree roots were present (precise root biomass present in soil where lysimeters were inserted)? It is important to understand whether exudates mimics were incorporated nearby plant rhizosphere. P6909 L8-14 The method for measuring soil proteolytic enzymes is not enough clear. I know that papers describing the method have been published elsewhere but it is important to understand principle of the method. P6910 1-10 The model do not consider

C2786

a plant compartment. For the comparison of model predictions and experimental results, how did you take into account effects of living plants on soil functioning (i.e. plant exudation, plant N uptake etc). You should discuss these questions and present main assumptions of the model. P6912 When possible, it would be nice to interpret predictions of the model in light of your knowledge of model structure and assumptions. Why does this model yield such results? P6915 L5-18 All these citations confirm that the cause-and-effect relationship between root exudation and enhanced microbial activity in rhizosphere is not new. My objective is not to diminish the importance of your study but to help you to insist on what is more original : the stoichiometric constraints of rhizosphere microorganisms and the role of plant N exudation on microbial activities. P6916 L9-13 This sentence is too general since the delivery of exudate mimics increased activity of enzymes that decompose labile substrate (generally N poor substrates) and decreased activity of enzymes that decompose recalcitrant SOM. What is the model prediction about the type of enzymes (enzymes degrading recalcitrant substrates versus enzymes degrading labile substrates) stimulated by the delivery of exudate mimics? P6917 L15-18 The reduction of activity of enzymes decomposing recalcitrant substrates after delivery of exudate mimics (C and N) could be due to an effect of N alone (see references in General comment). This is the reason why I think that the experimental plan lacks of a +N control to be able to clearly understand the role of plant exudates.

Good luck

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C2787