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Interactive comment on “Can we manipulate root system architecture to control soil erosion?” by A. Ola et al.

Anonymous Referee #1

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General comments:

The present paper addresses the link with root system architecture and their effects in controlling soil erosion processes. More particular the authors question if it is possible to manipulate the root system architecture in order to increase the effectiveness of plant species in reducing soil erosion rates. The manuscript starts with an overview of the role of plant roots on the soil erodibility. In a second part the effect of localized nutrient supply on root system architecture is discussed and linked to soil erosion rates. However, the link with soil erosion processes should be more highlighted throughout the manuscript.

Overall, no clear answer is given on the question stated in the title as almost no studies

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were performed to test this hypothesis within the field. Within the literature review also contradictory results are given based on laboratory experiments leading to a large uncertainty of the possibility of manipulating the root system in order to control soil erosion processes. Nevertheless the paper pointed out this lack of studies within this research field and proposed several important research opportunities.

Specific comments:

Overall, the link with erosion reduction is not explained into detail within the manuscript. It is also important to specify the erosion process that will be considered: e.g. shallow mass movements, erosion due to concentrated flow, splash detachment, interrill erosion, By reading the manuscript the structure and titles of the different sections were not always clear to me.

To structure my comments, I will discuss every section separately:

Abstract p 266, l 15: “at the soil surface dense root mats of roots may block soil pores thereby limiting infiltration, enhancing runoff and thus erosion”. This suggests that a dense root mat in the topsoil will increase erosion rates while several studies showed that dense roots mats decrease the amount of soil erosion rates (e.g. De Baets, S., Poesen, J. (2010). Empirical models for predicting the erosion-reducing effects of plant roots during concentrated flow. *Geomorphology* 118: 425-432). So this statement is a bit contradictory with the existing literature on roots effects on soil erosion in the topsoil.

It is important to consider that concentrated flow erosion is an incisive process which starts with the development of small rills at the soil surface which could be develop into large gullies. Therefore it is important to have a dense root mat at the soil surface. Based on the plant species considered the amount of roots decreases with soil depth. Therefore the manipulation of roots at greater depth and their proliferation will indeed protect the subsurface soil when the topsoil is removed by soil erosion processes.

1 Introduction

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The introduction handles soil erosion processes by water and its consequences for the land. However, the introduction mainly focuses on soil erosion and the effects of above ground vegetation while the effects of plant roots are only briefly mentioned. Even noting is said about the manipulation of root systems and the link with nutrients to accomplish this root manipulation. In that sense, the introduction is more a separate section instead of an introduction of the whole paper.

p 268, l 6: "... vegetation modifies intrinsic soil properties. ..." which is definitely true, however these are 'mainly' the result from the root effects on the soil properties which is also highlighted in Figure 1. But these are already discussed in the next section.

p 268, l 17: "... the presence of vegetation influences soil erosion rates". This conclusion is not explained into detail within the text. Therefore, more attention should be paid on the relation with soil properties and soil erosion processes. One can ask: Which soil erosion processes? In which way are soil erosion rates influenced by vegetation cover?

Within the introduction several repetitions occur, for example at p 268, l 8-12: "The above ground biomass

The second objective should be more specified in terms of which soil erosion processes that will be influenced by deep fertilizer applications as this is now unclear. Within the objectives soil erosion due to water are mentioned however within the paper also soil shear strength is mentioned in relation to the root tensile strength. These are mainly used within stabilization measures on slopes and the protection against shallow mass movements. Therefore, this type of erosion process should also be mentioned within the objectives.

2 The effects of roots on soil erodibility

Section 2 discusses the effects of roots on soil erodibility, which is schematically shown in fig.1. However this figure should be more used within the text. Within this section

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the link, between soil physical factors affected by plant roots and their effect on soil erodibility, is absent. This should be more explained. See for example: Knapen, A., Poesen, J., Govers, G., Gyssels, G., Nachtergaele, J. (2007). Resistance of soils to concentrated flow erosion: A review. *Earth-Science Reviews* 80: 75-109.

p 271, l 4-8: What is meant by ‘barriers to overland flow’? It is a difficult sentence to read. The last paragraph of this section is not integrated in the major part of section 2. This section can be implemented in section 3. Or it can be implemented within each of the paragraphs within section 2. E.g. the effects of RLD on soil shear strength, the effects of RLD on aggregate stability, I was wondering why only RLD is mentioned while the most frequent used root parameter within erosion studies (concentrated flow erosion) is root density.

p 272, l 13-15: “Furthermore, higher” Unclear sentence, maybe some part of the sentence is missing?

3. Root system architecture and its manipulation

In the first paragraph of this section the effects of different root system architecture on the soil erodibility are discussed as well as the effect on soil shear strength, aggregate stability which is already discussed in the previous section. A part of this section is namely a repetition of earlier discussed topics which were now applied on LRs. As only the last sentence of this section deals with the manipulation of the root system architecture, it is not very clear why this is a separate section within the manuscript. Therefore I would suggest combining section 2 and 3. By structuring those sections several repetitions (e.g. p 273, l 18-21; p 274, l 3-8) could be avoided.

4. Lateral root proliferation in response to local nutrient availability

p 275, l 12-15: “The same is true . . . “. This sentence is a little bit confusing. Does “ . . . revealed similar results” relate to maize?

p 276, l 12-13: “Thus a 30-fold increase . . .”. This sentence is not very clear. Does it

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relate to the previous sentences? This should be more explained.

A table with studies could be helpful to structure all facts concerning the effects of root systems on nutrient availability within this review.

5. Manipulating root system architecture with deep fertilizer placement to control erosion

See remarks conclusions

6. Effects of LR proliferation on the above-ground material

The link with this section and the overall goal of the paper is not clear. This could be solved by mentioning the beneficial effects of plant cover in controlling soil erosion processes if there is an effect on the above-ground biomass.

p 279, l 10-13: “More C is required . . . “. This sentence is unclear for me and should be explained more.

7. Conclusions

Within the conclusions new topics were discussed, namely the implementation methods for specific fertilizer methods p 280, l 21 – p 281, l 3). However this could be better implemented within section 5.

Technical comments:

p 268, l 26: Zhou and Shangguan, 2007 (not in reference list) See also p 271, l 24

p 269, l 21: Haynes and Beare, 1995 (not in reference list) Should it be 1997? See also p 270, l 7, 11, 14)

p 272, l 10: “RLD of barley”. De Baets et al., 2007 used grass and carrots in their experiments instead of barley.

p272, l 20: Malamy, 2005 (not in reference list) See also p 272, l 21; p 274, l 21

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p272,l 24: McCully, 1999 (typing error)

p 273, l 11: De Baets et al., 2007 (typing error), see also p 273 – l 13, 17, 27; p 277, l 11

p 274, l 2: Walker et al., 2003

p 274, l 25: Stokes et al., 2009

p 275, l 7: "A series of studies by Drew . . .". Maybe it is better to give the full references here.

p 277, l 1: no reference is given?

p 277, l 3: specify "responsiveness of . . . to . . . varies between . . ."

p 278, l 2: De Baets et al., 2008 ? (see also l 5)

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