Dynamics of root growth in response to grazing intensity and climate variability of a permanent upland mesic grassland

Catherine Picon-Cochard, Nathalie Vassal, Damien Herfurth, Sandrine Revaillot, Stéphane Sauvat, Priscilla Note, Frédérique Louault

Dynamics of root growth of upland grasslands in response to grazing intensity and climate variability

UREP Grassland Ecosystem Research Clermont-Ferrand

Picon-Cochard Catherine[1], Vassal Nathalie[1,2], Herfurth Damien[1,2], Revaillot Sandrine[1], Sauvat Stéphane[2], Note Priscilla [1,3], Louault Frédérique[1]

[1]INRA UR874, Grassland Ecosystem Research, Clermont-Ferrand, France; [2]Université Lyon, VetAgro Sup, INRA, UREP, F-63370 Lempdes, France; [3]INRA, UE1414, Herbipôle, Saint-Genès-Champanelle, France

Contact: catherine.cochard@clermont.inra.fr

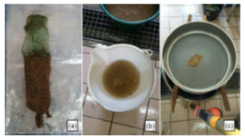
INTRODUCTION

In permanent grassland, root activity (growth, exsudation, mortality) contributes to the main inputs of C and N compounds into the soil. Understanding how root activity and soil C stock respond to management is of prime importance for providing ecosystem C sequestration service. Lower below-ground net primary production (BNPP) is expected in intensive than in extensive grazing treatments due to stimulation of shoot mass at the expense of roots.

Cattle+ Grazing intensity Cattle- Abandonment

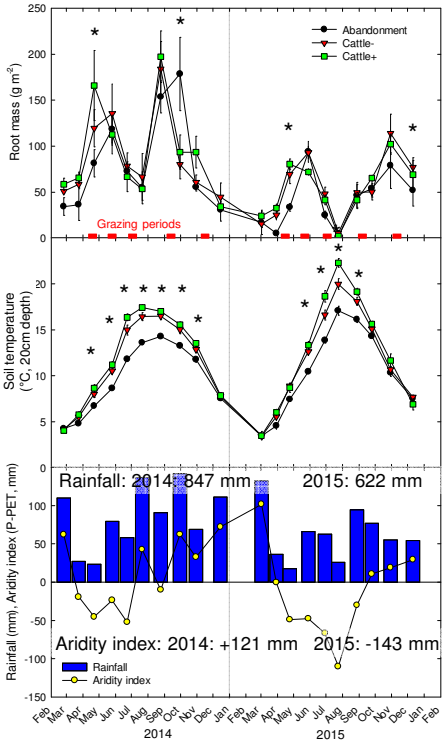
METHODS

The site is part of the long-term observatory network (SOERE-ACBB) located at St-Genès-Champanelle (upland area in the French Massif Central). Grassland is managed since 10 years with a gradient of grazing intensity: abandonment, low (Cattle-) and high (Cattle+) stocking density (0, 6.9 and 13.8 LSU ha^{-1}, livestock unit, respectively) with 5 grazing rotations each year. Dynamics of root mass production was measured with in-growth cores, inserted in the 0-20 cm soil layer and collected 10 times each year during two years (2014 and 2015). Root mass stock was measured 3 times (spring, summer, autumn) the first year and annual root turnover was calculated as the ratio of annual BNPP to mean root mass stock. Soil temperature measured at 20cm depth was averaged at daily scale.

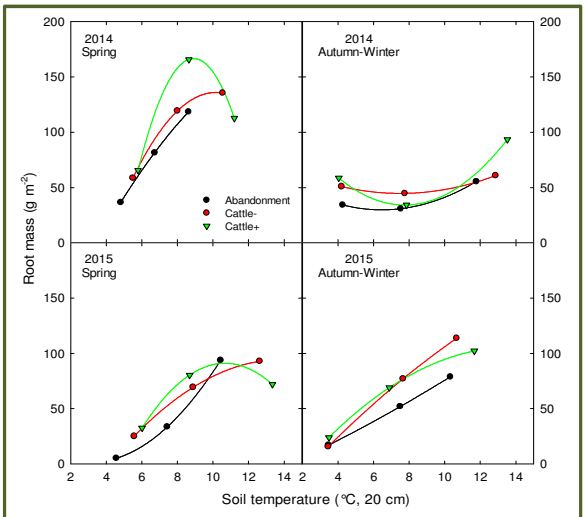


4 in-growth cores / plot
4 plots / treatment
3 treatments
10 dates / year

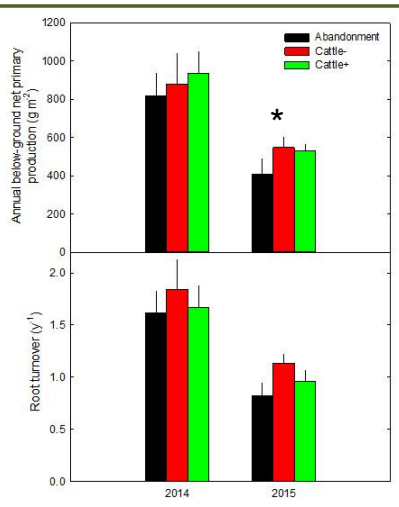
RESULTS



- Root production peaked twice in Spring and late Summer early Autumn for all treatments and occurred earlier in grazed Cattle than in Abandonment treatments. This can be related to higher soil temperature measured in grazed plots.
- The second year was drier than the first year, especially in Summer. This led to very low root mass production and to a delay for the second peak of root mass production in autumn.



- For spring 2014 and 2015, soil temperatures measured at date numbers 2, 3, 4, 12, 13 and 14 are shown; For Autumn-Winter 2014 and 2015, soil temperatures measured at date numbers 1, 9, 10,11, 19 and 20 are shown.
- Soil temperature increases in Spring and Autumn-Winter led to higher root mass across treatments. But the first grazing rotation in May reduced root mass earlier in Cattle+ than in Cattle-.
- In Summer, soil dehydration is expected to be the main driver of root mass reduction.



- Warmer and drier climatic conditions in 2015 reduced both annual root production and root turnover by about 44%.
- Overall, cattle treatments showed higher root mass than Abandonment leading to higher BNPP in 2015 (+32%) the drier year.
- Root turnover values ranged between 0.97 and 1.7 y^{-1}, which are similar and higher than data from literature for temperate grassland, respectively (Gill and Jackson 2000; Leifeld et al 2015).

CONCLUSIONS

- No important changes of root mass production and BNPP were observed in response to the grazing intensity gradient although above-ground biomass and botanical composition were affected (Herfurth et al 2015). However soil temperature was lower in Abandonment than in Cattle treatments, due to litter accumulation, slowing plant greeness and delaying root production.
- Altogether these results showed that inter-annual climatic conditions had a more pronounced effect on root production than management for upland permanent grassland. Thus it can be expected that climatic variability increase should slow root mass the dry years and thus should affect soil C stock.

References
Gill RA, Jackson RB. 2000. Global patterns of root turnover for terrestrial ecosystems. New Phytologist 147: 13–31.
Herfurth D, Vassal N, Louault F, Alvarez G, Pottier J, Picon-Cochard C, Bosio I, Carrère P. 2015. How does soil particulate organic carbon respond to grazing intensity in permanent grasslands? Plant and Soil, 394, 239-255
Leifeld, J., Meyer, S., Budge, K., Sebastia, M.T., Zimmermann, M., and Fuhrer, J. (2015). Turnover of grassland roots in mountain ecosystems revealed by their radiocarbon signature: Role of temperature and management. PLoS ONE 10, e0119184.