Spatial and temporal dynamics of microbial parameters in northeastern French agroforestry systems

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Context

Agroforestry appears as an ecological diversification for the farmers in the French context even if technical-economic references and the evaluation of ecosystemic services inherent to tree introduction are currently lacking in the north-east part of the country. In this context, the goal of our experiment was to evaluate the impact of tree introduction on one soil regulation service corresponding to the ability to furnish inorganic nitrogen for plants through microbial soil organic matter mineralization.

Material & Methods

Experimental sites:

- 6 alley cropping agroforestry systems in different pedoclimatic conditions
- Soil sampling (0-15 cm) in May 2020, 2021 and 2022
- Five distances (1. tree, 2. half crown, 3. crown, 4. crown + half crown, 5. interrow)
- 3 replicates / distance

Initial soil characterization (0-15 cm):

Site	Clay (%)	Loam (%)	Sand (%)	pH	Organic matter (%)	Total N (%)	CEC
BAN	25.8	66.4	7.8	8.0	2.1	1.48	14.1
FQ	31.1	64.8	4.1	8.1	3.0	1.87	16.8
HEN	33.1	59.8	7.1	8.1	5.3	3.17	18.6
MON	37.3	32.8	29.9	8.2	3.0	1.88	15.5
ORB	22.4	27.9	49.7	6.5	2.5	1.47	10.8
PIX	26.8	28.6	44. 6	7.9	4.8	2.5	17.7

Banogne (BAN), Ferreux-Quincey (FQ), Hennecourt (HEN), Montenoy (MON), Orbigny au Mont (ORB), Pixérécourt (PIX)

Soil C and N pools:

- Hot water carbon (HWC*) and nitrogen (HWN*) extracts
- Microbial biomass carbon (MBC) and nitrogen (MBN)
- Inorganic nitrogen and sulfur contents

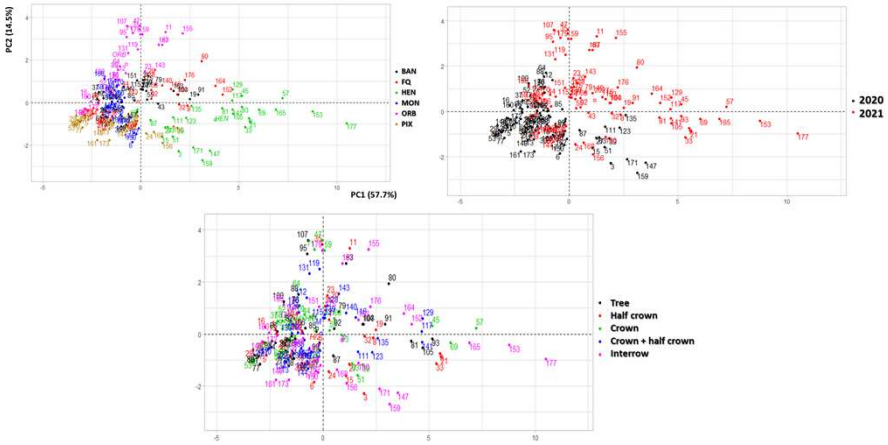
Microbial traits:

- Bacterial (qPCR 16S) and fungal (qPCR ITS) abundance
- Bacterial diversity (16S metabarcoding)
- Enzyme activities related to SOM mineralization:
  - leucine aminopeptidases LAP*
  - N acetylglucosaminidases NAG*
  - arylsulfatases ARS *
  - β-glucosidases BG*
  - acid phosphatases AP*

**Data used for Principal Component Analysis*

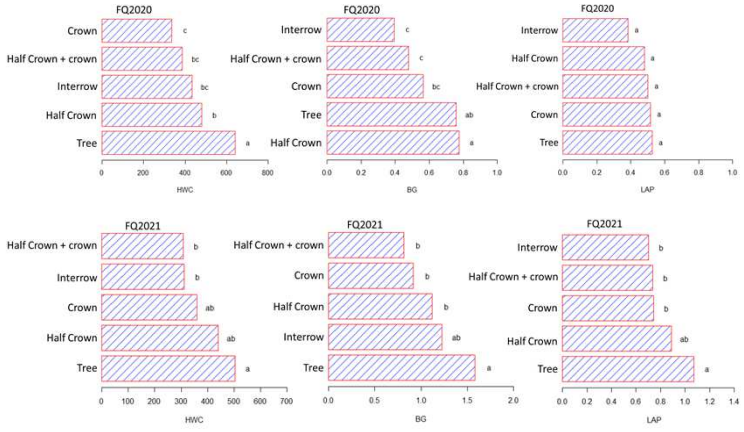
Results

Effect of pedoclimatic conditions and interannual variability



- Microbial parameters are more strongly dependent on the kind of agroforestry systems and on pedoclimatic conditions than on the distance to the trees.

Effect of tree distance on Ferreux-Quincey (FQ) site, a conventional annual cropping system



- Significant effects of tree were found on labile carbon content and on enzymes relative to carbon and nitrogen mineralization
- Labile carbon content decreased from the trees to the middle of the field in 2020 and 2021
- Enzyme activities were higher around the tree and were twice higher in 2021 compared to 2020

Conclusion

The results showed that microbial parameters were more strongly dependent on pedoclimatic conditions than on the proximity of the trees with a site-specific response pattern. For FQ site, labile carbon pool and microbial activities were higher close to the trees probably because of the litter deposition and nutrient competition.