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N-microbial properties are key indicators of fertility in maturing soils built for urban greening.

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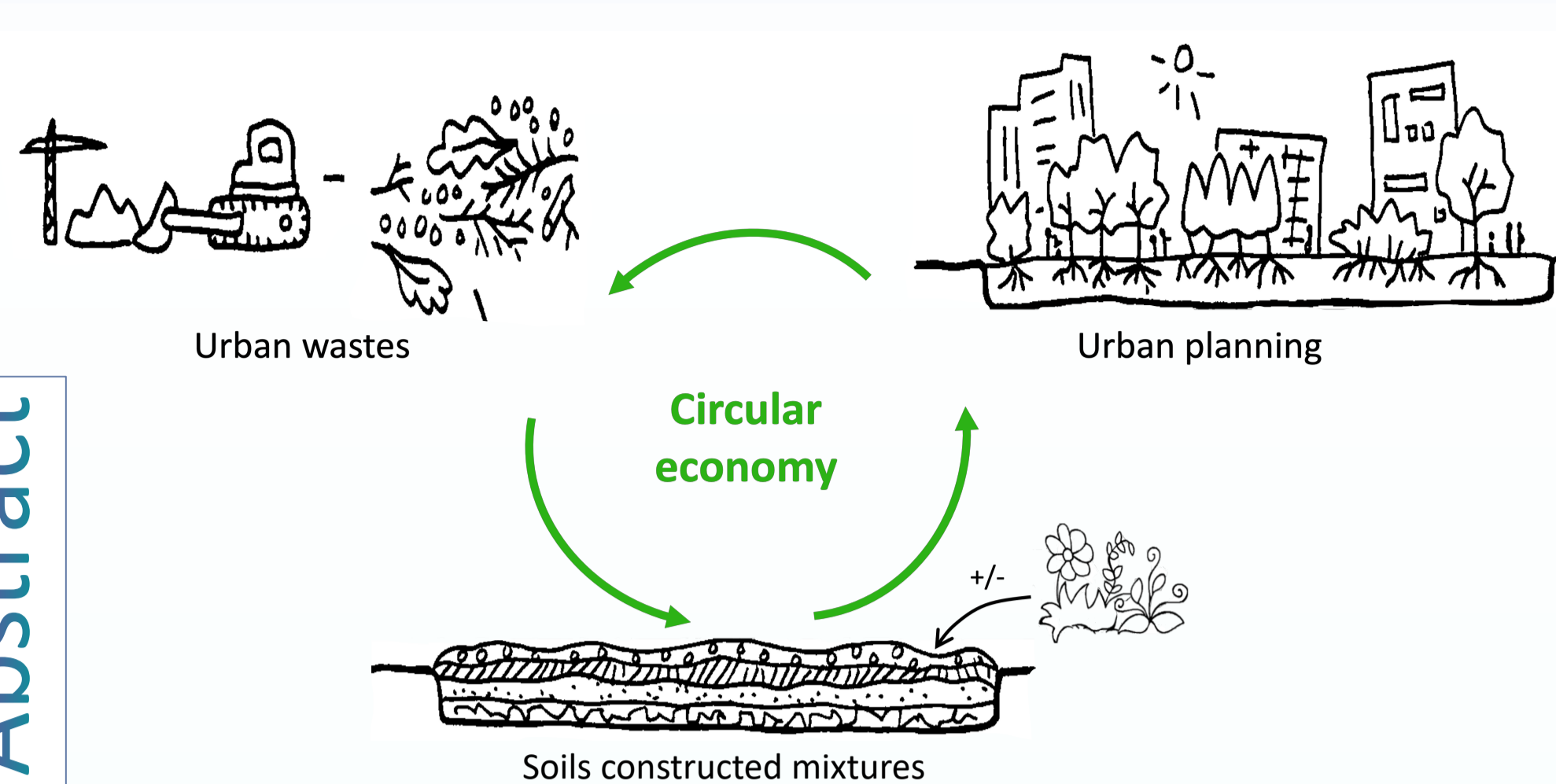
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Durand, M., Legay, N., Le Guyader, N., Gervais, J., Czarnes, S., Pommier, T.

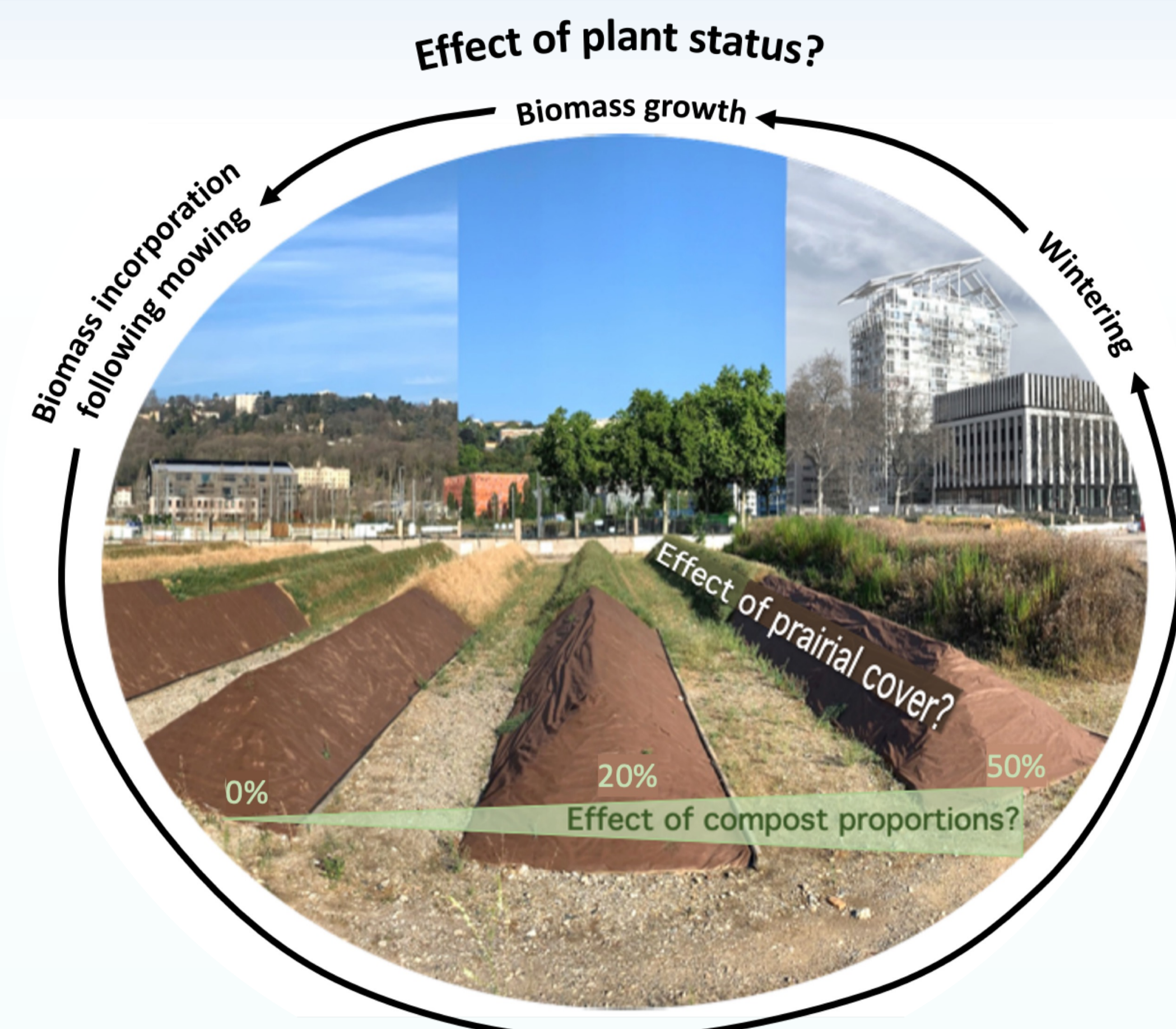
Abstract



Soils constructed from urban planning wastes provide a sustainable solution for urban planners to design urban green spaces that meet the growing demand for nature in the city while limiting artificialization of peri-urban agricultural areas. However, while the pedological and chemical characteristics of these constructed soils are easily assessed, their biological fertility, and especially their nitrogen (N) availability, remains essentially associated to their inhabiting microbial communities. Accordingly, the stability of microbial N-functioning and the prerequisite time to provide sufficient N to plant covers is an under-explored ecological question.

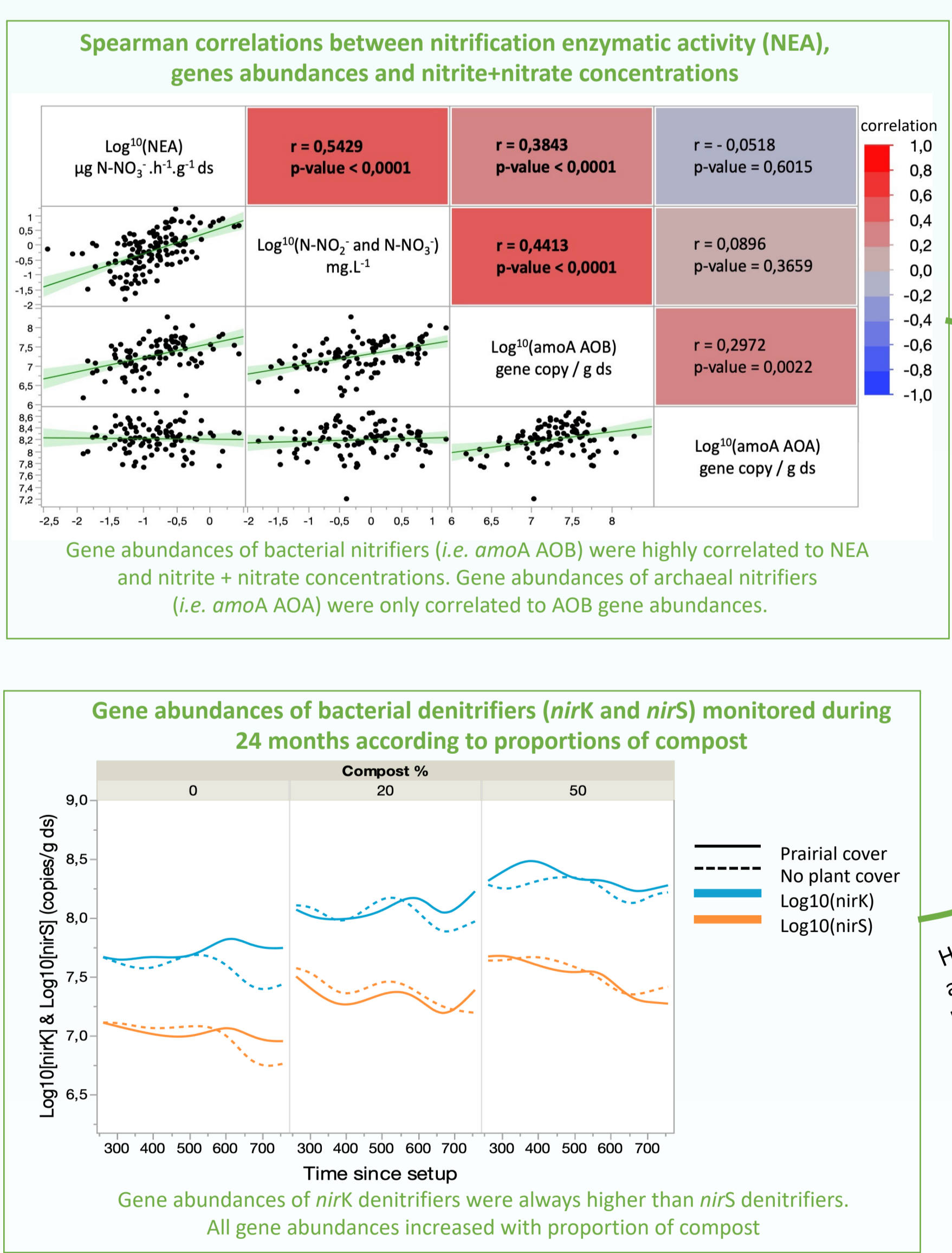
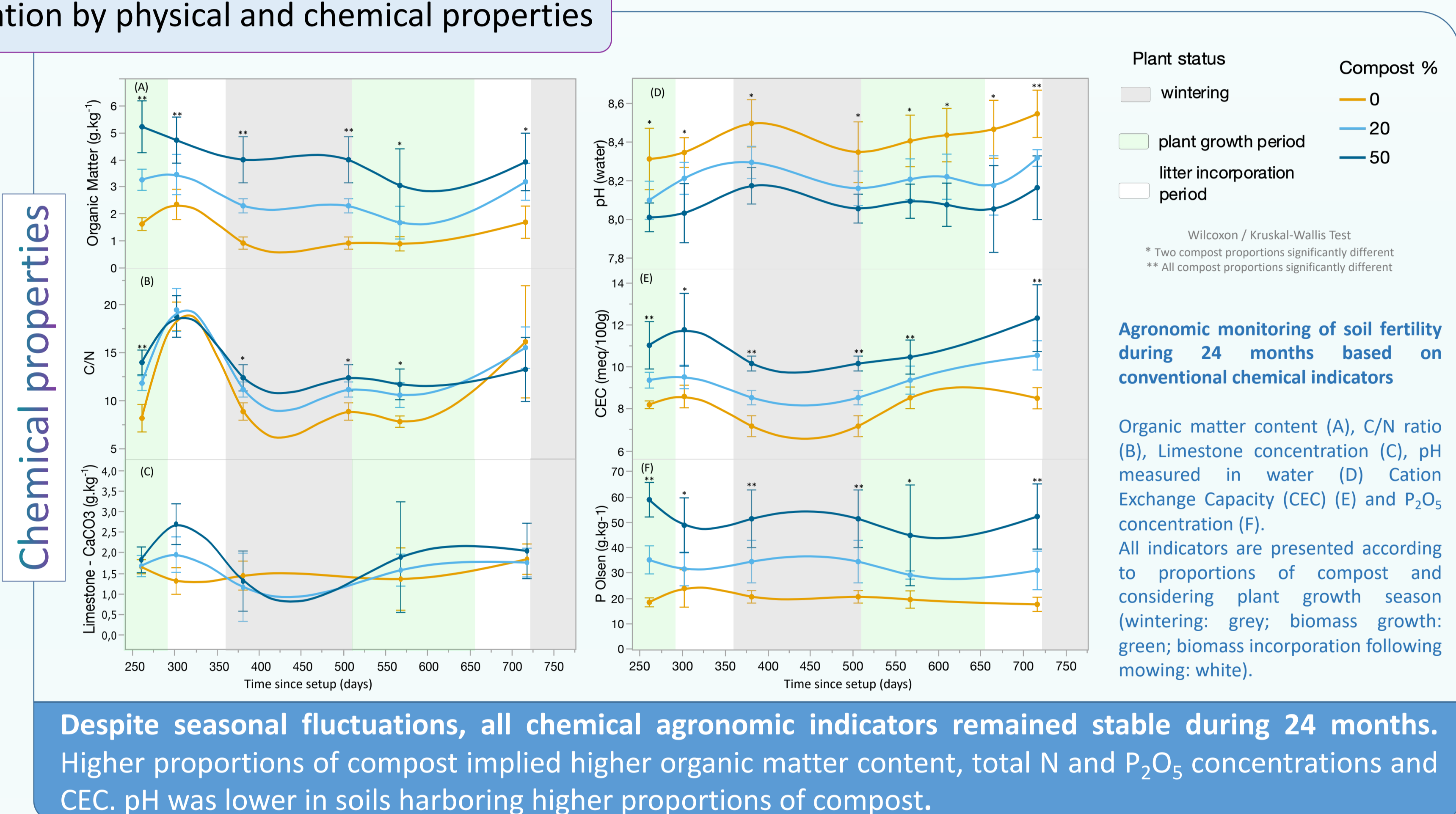
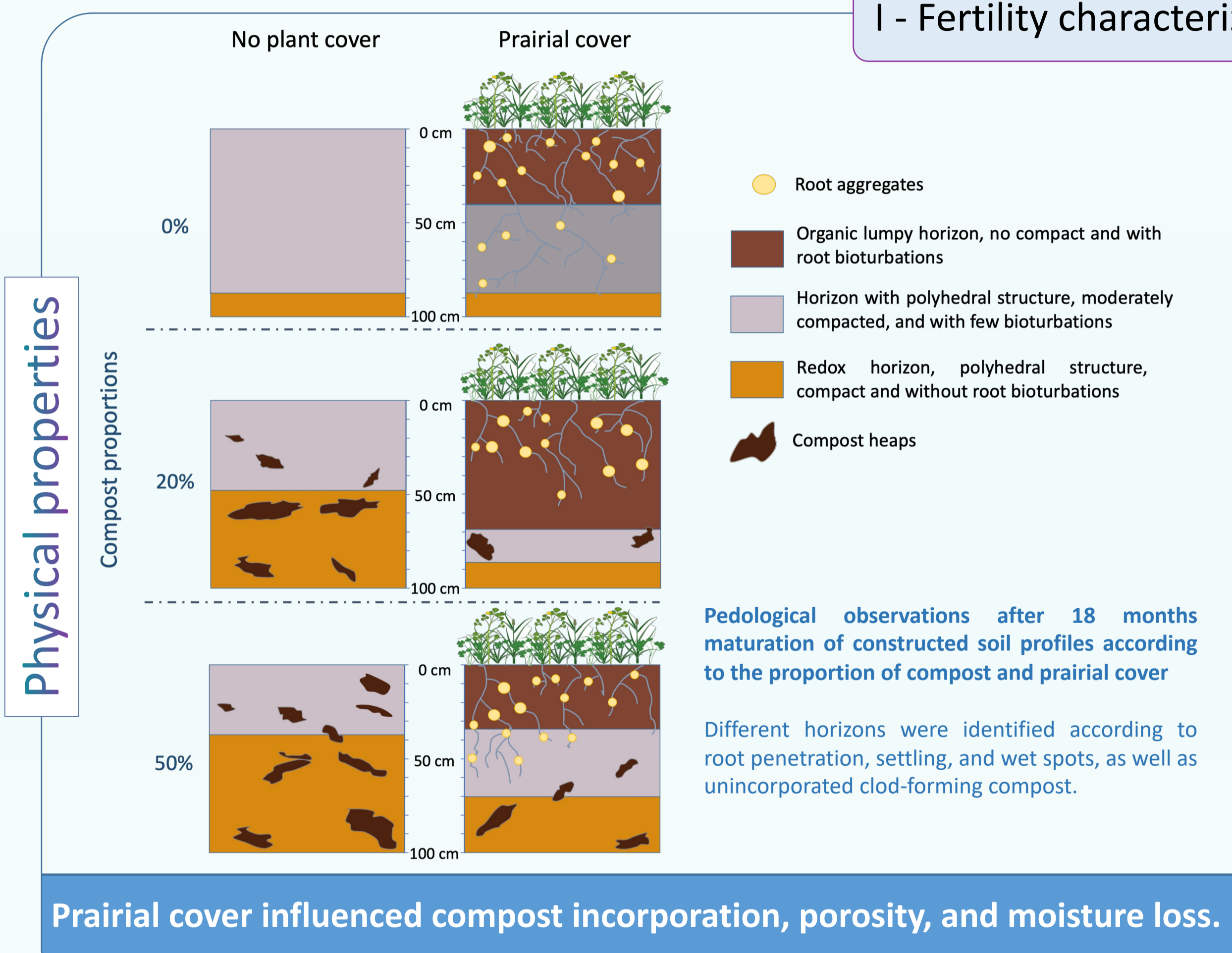
To address this issue, nine soils were constructed from compost, topsoil, and deep soil mixed in different proportions. Half were hydroseeded once with a mixture of annual and perennial plants. We then monitored soil fertility for 24 months, to cover two growing and two wintering seasons, and assess N cycle seasonality in regards of plant community development and pedological and chemical characteristics. Free-living microbial N-fixation, nitrification and denitrification enzyme activities were measured in soil incubations following acetylene reduction assays, colorimetric quantifications of nitrite/nitrate accumulation, and N₂O gas chromatography, respectively. Relative abundances of genes associated to these enzyme activities were assessed using targeted quantitative PCR.

Our results suggest microbial indicators of soil functioning are truly relevant to monitor biological fertility of constructed soils in urban ecosystems.

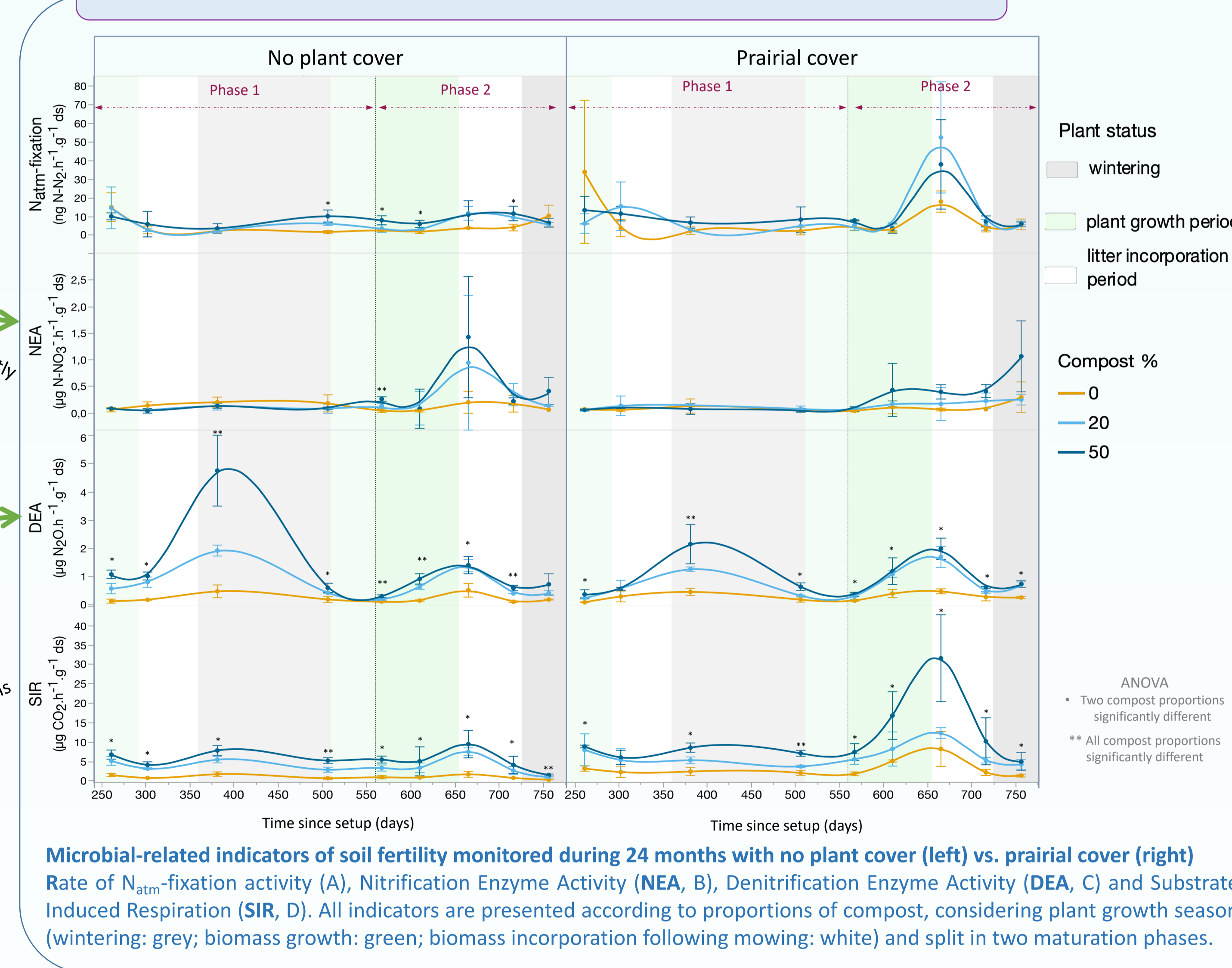


Overall experimental setup and associated questions to assess the optimal conditions favoring compost-soil mixtures destined for urban greening. The soil piles were built in La Confluence area in Lyon, France to be directly used during neighborhood rehabilitation. They were kept for maturation and scientific monitoring from November 2019 to March 2022 (24 months).

I - Fertility characterization by physical and chemical properties



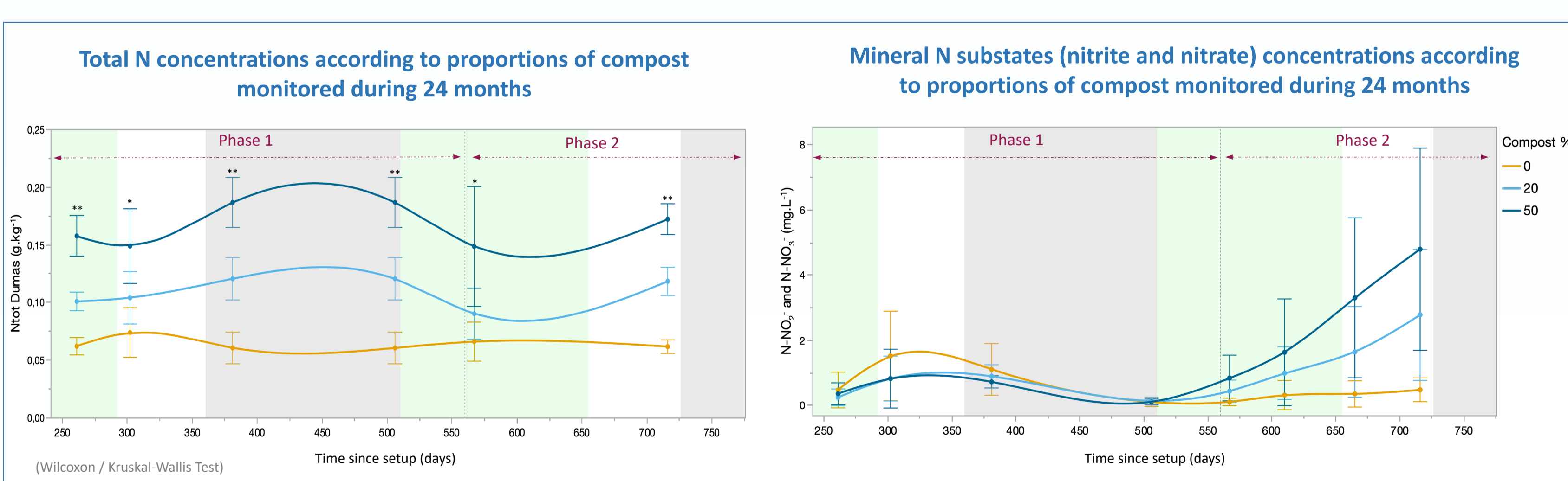
II - Biological fertility characterization by microbial activities



Two maturation phases
Rates of NEA, N_{atm}-fixation and SIR enzymatic activities remained low during the first 18-month maturation (phase 1), and drastically increased after (phase 2), especially under prairie cover for N_{atm}-fixation (at 665 days) and SIR (from 610 to 756 days).

Prairie cover decreased rate of DEA (phase 1)
Suggesting a competition between plants and denitrifiers for the nitrate resource

Addition of compost increased heterotrophic activities (i.e. DEA and SIR)



Conclusion

- Agronomic indicators**, usually monitored for soil fertility, showed **no significant difference** during 24-months maturation, but some of them underlined the effects of proportions of compost and prairie cover.
- Microbial properties** more precisely showed the soil maturation phases:
- Initial materials effect : with heterotrophic microbial activities (DEA, SIR and to a lower degree N_{atm}-fixation)
 - Plant cover benefits : on all microbial activities at different levels
 - Soil N-availability better disclosed by NEA
 - AOB-nitrifiers gene abundance could reveal variations in NEA
 - Best time to setup : when N-enrichment activities were higher

While N_{tot} concentration showed the effect of the proportion of compost, nitrite and nitrate concentrations, associated with microbial communities, better revealed N-availability for plants