Impact of an innovative vine soil management on soil fertility

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Objectives:

Good yield wine production implies well-balanced BCN (biogeochemical cycle of nitrogen), in soil and plant [1]. Nitrogen is very important for grape quality and soil sustainability. Organic nitrogen mineralization is the main source of mineral nitrogen for the vine [2][3][4][5]. It depends on soil microbial activity which is linked to soil cover crop management. This study is focused on the microbial soil biomass and activity related to nitrogen mineralization and dynamic in soil.

Material & Method:

Experimental network has been set up since 2012, with 6 vine sites located France by the Atlantic coast (Loire valley: two integrated systems, Loamy, sandy and clayey soil / Bordeaux: organic and integrated systems, Sandy soil) and in North-East (Ribeauvillé-Alsace organic and integrated systems, Loamy, sandy and clayey soil / Rouffach-Alsace, two integrated systems, Loamy, sandy and clayey soil / Ingersheim-Alsace organic, Sandy loam soil / Chatenois-Alsace organic, Sandy silty and clayey soil). These vine sites represent a diversity of environmental factors (i.e. soil and climate) with 11 sites-systems having different management (soil, products' input and farmer's practices). Studied systems are either Integrated or Organic. All systems are innovative and deal with low or very low pesticides inputs.

The approach consists in measuring biological and chemical indicators to assess nitrogen dynamic in soil, i.e. nitrogen mineralization, regarding microbial biomass and activity. Soil microbial communities (bacteria and fungi) are studied with quantitative PCR (Polymerase Chain Reaction) measures targeting 16S (bacteria) and 18S (fungi) DNA. Metabolic functional diversity of cultivable bacteria is determined using Biolog® Ecoplates systems with 31 carbon and nitrogen substrates. Potential nitrogen mineralization is evaluated in microcosm incubation with controlled condition (temperature and moisture used for soil incubation are those proposed by standard ISO 14238).

In 2014 and 2015, soils were sampled in triplicates at 3 dates: bud breack – veraison – leaf fall.

Statistical analyses are performed to determine the relationship between biological indicator and nitrogen mineralisation regarding farmer's practices.

Results & Discussion:

In 2014 and 2015, for Alsacian sites (6 sites/systems), organic systems present higher values of functional richness than for integrated ones, this is particularly observed at bud breack, even if differences are not significant. Bacterial abundance measured in Ribeauvillé by qPCR showed higher bacterial biomass in organic system than in integrated one. Stimulation of bacterial activity (functional richness) was also observed for this system. In Chatenois and Ingersheim farming systems are not only organic but also biodynamic; High functional diversity and high bacterial biomasses are measured for these two sites, at all dates of measure. This may be explained by organic farming since more than 10 years on these sites while others sites are

organic for shorter periods (less than 10 years).
In 2014, higher functional diversity is measured for integrated system in Aquitaine at bud breack. This difference is not observed anymore after that date. In Loire valley, there's no difference on functional diversity between the two studied systems. Lower bacterial abundance is observed for integrated system at veraison in Aquitaine both in 2014 (strong effect) and in 2015 (tendency).
No difference is observed on soil organic nitrogen content in Atlantic coast sites according to farming systems. However, significant differences are observed in Alsacian sites with higher soil organic nitrogen in integrated systems. Nitrogen mineralization kinetic is measured for 90 days. Results are used to model mineralization in all soils depending on time. For Alsacian sites, the highest mineralization rate is observed for integrated system in Ribeauvillé and the lowest rates for Ribeauvillé organic and Rouffach integrated systems. For Atlantic coast, Loire valley sites have higher mineralization rates than Aquitaine ones in 2014, but this effect is not maintained in 2015. In addition, management practices affect rate of nitrogen mineralization in Aquitaine sites-systems. However, this is observed only in 2015 when nitrogen mineralization is higher comparatively to the 2014. These results indicate that management practices affect net mineralization of nitrogen but this effect seems to be less pronounced than effect of environmental factors.
To study how technical management of the sites-systems explain measured parameters (soil mineralization, soil microbial populations, physic-chemical parameters of soil), a Principal Component Analysis is performed. This analysis highlights a strong effect of environmental factors on measured parameters as figures are grouped by sites. However, type of systems also influenced our results: Alsacians and Loire valley sites are grouped depending on type of systems. This is not observed for Aquitaine sites, but the type of soil (sandy) has a great influence especially on mineralization parameters. Furthermore, this site is also the youngest vine (3 years).

Conclusions & References

Environmental factors have strong effect on microbial indicators in vine soils. The sites-systems studied showed effect of farming practices (Integrated or Biological) on measures of bacterial abundance (qPCR), of bacterial functional diversity (Biolog® Ecoplates) and of nitrogen dynamic. These BCN indicators can be combined to differentiate between sites-systems according to management practices. These indicators could help in managing nitrogen dynamics and nitrogenous nutrition of vine in innovative sites/systems with various farming practices.

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