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Shift from dormancy to microbial growth revealed by RNA:DNA ratio

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Although soil microorganisms spend most of their lifetime at dormant or resting states, they are quickly activated by substrate input and easily switch to growth. Under steady-state, the double-stranded DNA (dsDNA) content is considered as a measure of total microbial biomass while the RNA content mainly indicates the active microbial fraction. In growing population, however, an increase in DNA is solely related to replication of microbial cells, while the RNA, besides growth, is also involved in non-growth processes. Therefore, the dsDNA and RNA content increase differently during microbial growth, applying the RNA:dsDNA ratio as promising indicator of growth-related and non-growth microbial activity. To what extend the ratio can be used to comparatively infer investment in microbial biomass production versus maintenance-related synthesis following substrate induction remains to be studied.
We measured the RNA:dsDNA ratios of representative soil types of four different ecozones before and after glucose addition to prove the prediction capacity of physiological status of soil microorganisms. The RNA:dsDNA ratio remained stable after activation of microorganisms in Retisol and Luvisol indicating balanced growth. In contrast, very moderate increase in DNA in sandy Calcisol was accompanied by disproportionally high increase in RNA. As a result, the RNA:dsDNA ratio in Calcisol with low nutrient status increased by 36-fold after glucose amendment, indicating strong non-growth related processes. The RNA recovery decreased exponentially with increasing clay content, indicating the strong association to the textures of the soil types. This suggests, that the underestimation of RNA yields in clayey soils biased the RNA:dsDNA ratio, and subsequently the physiological state of the microbial community is not adequately represented in soils clay contents exceeding 30%. Monitoring the relative changes in dynamics are required to overcome the restricted applicability of RNA:dsDNA ratio in soils with high clay content.