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Salehi, Aliyeh and Gorfer, Markus and Surböck, Andreas and Strohmeier, Stefan Martin and Seidel, Sabine and Gregur, Paola and Berger, Harald and Gollner, Gabriele, Soil **Physicochemical Properties, Microbial Communities, and Lucerne Performance under Organic Fertilization in a Long-Term Cropping System in Austria.**

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Soil profile stratification under long-term organic fertilization: responses of soil fertility, structure, and microbiomes in a lucerne-based rotation

Long-term organic fertilization influences soil fertility, structure, and microbial communities, but the vertical distribution of these effects is not well studied, particularly in dry sub-humid regions where topsoil stratification can be pronounced. We evaluated how contrasting organic fertilization systems shape soil functioning and lucerne (*Medicago sativa* L.) performance within a long-term organic rotation in eastern Austria. Four fertilization systems were compared: FS1 (GM; stockless, two-year lucerne green manure), FS2 (GM+MC; stockless, GM plus municipal compost), FS3 (FU+FYM; livestock, lucerne forage-use plus farmyard manure), and FS4 (FU+BD; livestock, lucerne forage-use plus biogas digestate). Soil was sampled at 0–15 cm (topsoil) and 15–30 cm (subsoil); aggregate stability was assessed in the surface layer (0–5 cm). Across all systems, soil depth was the main driver of chemical, physical, and microbial patterns. SOC and TN, plant-available P and K, pore volume, and bacterial and fungal gene copy numbers decreased from 0–15 cm to 15–30 cm, whereas pH and bulk density increased with depth. Depth also strongly structured bacterial and fungal community composition, with fungal communities showing clearer responses to fertilization system than prokaryotic communities. Management effects were most evident in the topsoil: GM+MC and FU+FYM showed higher topsoil P and especially K, and tended to improve soil structure compared with GM and FU+BD. Despite these soil differences, lucerne dry-matter yield did not differ among fertilization systems, while the first cut consistently yielded more than the second cut. Overall, long-term organic fertilization primarily modified *topsoil* fertility and physical condition, whereas depth-driven gradients governed whole-profile patterns in soil properties and microbiome composition. These findings underline the need to explicitly account for soil profile stratification when designing lucerne-based organic systems under dry sub-humid conditions.

Key words: Bacterial community composition, compost (municipal compost), organic fertilization, soil organic carbon.

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