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Effects of long-term compost application on carbon content and soil physical properties

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Biological treatment through composting of organic wastes fulfils multiple purposes: it not only reduces the amount of waste stored in landfills but can also provide agricultural soils with organic amendments, which affect physicochemical soil properties and reduce the use of mineral fertilizers. However, the impacts of different types of amendments are not yet fully understood, as quantity and quality of the exogenous organic matter (EOM) applied vary greatly and numerous other parameters are affected as well, such as pH, heavy metal content, or nutrient availability.

The objective of this project was to investigate the effect of different organic amendments - via simulations - on water holding capacity (WHC) and particularly plant available water (PAW), in regard to irrigation needs. The long-term field experiment "Qualiagro" (INRA – Veolia Environment collaboration) was established in Feucherolles, France in 1998, where five treatments were designed, each with two levels of mineral nitrogen (N) addition: minimal and optimal. Farmyard manure (FYM) and three types of compost - all applied every other year at a rate of 4 t carbon ha-1 - gave rise to varying organic carbon (OC) contents and were compared to a control treatment. The treatments changed the soil's OC content from initially $\sim$10.5 g kg-1 to a range of 9.35 to 15.58 g kg-1. An increased OC content can enhance WHC by increasing total porosity/ reducing bulk density. The PAW - the difference between field capacity (FC) and permanent wilting point (WP); predicted with pedotransfer functions related to OC - increases, if the increase at FC is larger than that at WP. With a higher amount of PAW, the need to irrigate fields - to ensure sufficient water availability for plant growth - decreases. At the same time, soil bulk density (d) affects root growth; denser soils can lead to reduced rooting depth. Both of these effects were considered when employing a simple soil water balance model (BUDGET; http://www.iupware.be), which revealed a trend of improved water availability in organically amended soils. The improvement was dependant on the OC content: high-OC soils had slightly lower irrigation needs (expressed in mm water) than low-OC soils. When rooting depth was adjusted in relation to d, the difference between high- and low-OC soils became more pronounced; this effect was also notable for the amount of days at which irrigation was necessary.

Depending on the quality of EOM (size of labile and recalcitrant fractions), the amendments increased soil OC content, consequently increasing WHC and PAW; the reduced d can exert an additional positive influence on root growth conditions and the plant's ability to extract soil water stored in deeper layers.

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