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Influence of soil moisture on C incorporation and preservation in soil

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Sequestration of atmospheric C into soil is only mediated by plant. Plant leaf can use atmospheric C by photosynthesis, thereafter this C is translocated into soil through plant root exudates and root fragments. With changing climatic conditions like decreasing rainfall especially during growing seasons of plants, water availability is thought to raise as limiting factor for plant growth and thus sequestration of C. However, little is known about the pathway of translocation of C from atmosphere to soil at different moisture regimes. To quantify atmospheric C incorporation in plant and its preservation into soil via the rhizosphere, a laboratory experiment on Juncus effusus, which is adapted to very moist conditions, was conducted. The plants were kept at levels of 70 and 100% soil moisture (relative to field capacity, which was adjusted daily to a difference of 30% between high and low moisture levels) for several months. C uptake by plants and translocation towards soil was traced 3, 7, 14 and 21 days after $14CO_2$ pulse labeling in bulk carbon and lipid fractions of plants and soils.

J. effusus produced higher leaf and root biomass at 100% moisture as compared to 70% soil moisture. Consequently, rhizosphere-dry mass increased with increasing root biomass. Considering whole pot (plant & soil together), 14C proportion of shoots decreased and that of roots increased successively from 3 to 21 days after labelling due to translocation of C from shoots to roots. 14C content of rhizosphere was observed to be highest at day 14 after labeling at 100% soil moisture, implied an exceptional increase of root exudates, whereas root exudation was less in 70% soil moisture. As a result of C translocation from roots to soil, 14C content of soil increased until day 7 after labeling. Thereafter, soil 14C content decreased more sharply with time at 100% soil moisture than at 70% moisture. Moreover, to gain quantitative knowledge of 14C preservation, a comparatively recalcitrant C fraction, lipid-14C, was also measured. J. effusus leaf, grown at 70% soil moisture; showed higher percentage of lipid-14C of organic C, probably to protect higher loss of water through respiration. Similarly, rhizosphere and soil lipid-14C content were also high under 70% soil moisture, probably because of lower diffusion of root exudates at 70% soil moisture as compared to that at 100% soil moisture.

With these result it can be concluded that incorporation of 14C in soil was high in 100% soil moisture but preservation, of bulk C and in the form of lipid-14C, was higher under 70% than that of 100% soil moisture. This clearly explains commonly lower C contents in dry vs. wet soils, where the latter benefit from improved C incorporation, whereas preservation might be less pronounced.