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Biogeosystem Technique transcendental intra-soil pulse continuous-discrete watering paradigm for soil organic matter sustainable regime and heavy metal passivation

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Water regime determines the soil organic matter (SOM) content and dynamics and heavy metals (HM) availability for plants. Uncertainty natural hydrological regime is a consequence of combination of a phase of water supplying to the soil and a phase of water spreading into the soil, which causes biosphere diversity. Current gravitational frontal continually-isotropic irrigation paradigm stipulates huge consumption of the world freshwater reserves. Around 95% of this water uncontrollably spreads in landscape in result of natural hydrological regime simulation. This paradigm causes unsustainable soil organic matter regime and heavy metals uncontrolled penetration of HM into plant roots and then into trophic chains.

Improved biogeochemical cycle, including SOM and HM regime, is possible in the framework of Biogeosystem Technique (BGT*) transcendental methodology. An origin of the developed BGT* soil watering paradigm is an intra-soil pulse continuous-discrete water supply into the soil continuum, fulfilled sequentially. Discrete volume of water is supplied via syringe to the vertical cylinder of soil preliminary watering at a depth of 10 to 30 cm, diameter is of 1–2 cm. Within 5–10 min after injection, the water spreads from this cylinder of preliminary watering into surrounding soil via capillary, film and vapor transfer. Some amount of water is partially transferred gravitationally to a depth of 35–40 cm. The resulting soil watering cylinder is at a depth of 5–50 cm, its diameter is of 3–4 cm. Lateral distance between next injections along the plant row is about 10–15 cm. The non-watered soil carcass surrounding the wetted cylinder remains relatively dry and mechanically stable. After injection, the structure of soil in the wetted cylinder restores quickly without compression from the stable adjoining volume of soil, and the soil structure memory remain functional. The mean matric potential of the soil solution is 0.2 MPa. At this potential, a leaf stomatal apparatus operates in regulation mode. Relatively high concentration of soil solution provides an increased rate of plant supply with nutrients. Transpiration rate reduced compared to the natural water regime or standard irrigation. Evaporation from soil surface is small as well. Soil solution seepage to vadose zone is excluded. Fresh water saving is up to 20 times.

BGT* soil watering paradigm reduces rate of intra-soil mass transfer, and uncontrolled lateral water redistribution to landscape. In its turn, this reduces SOM leaching from soil and improves conditions for the SOM priority synthesis, providing humic substances function, soil structuring, intra-soil reversible C sequestration, improved plant supply with fresh nutrients, better plant organogenesis, and soil biological productivity. Intra-soil application of plant protection preparation is possible.

Rather low matric potential insures higher ionic strength of soil solution. Corresponding manifestations of ion association and carbonate calcium equilibrium in soil solution provide association of HM with macro-ions PbCO_3^0 , $(\text{PbCO}_3)_2^0$, PbHCO_3^+ , PbSO_4^0 , PbCl^+ , PbOH^+ , $\text{Pb}(\text{OH})_2^0$, CdCO_3^0 , CdHCO_3^+ , CdSO_4 , CdSO_4^0 , CdCl^+ , CdOH^+ and other, and consequent irreversible passivation of HM via complexation in soil mineral-organic system.

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