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The Role of Soil Cracking in the Structure Regeneration Process of the Compacted Agricultural Soil

Sung Won Yoon (1), Guy Richard (1), Hubert Boizard (2), and Jean Roger-Estrade (3)

(1) INRA, Unité de Science du Sol, Orleans, France (Sung-Won.Yoon@orleans.inra.fr), (2) INRA, Agro-Impact, Estrées-Mons, France, (3) AgriParisTech,SIAFEE,Thiverval-Grignon, France

It is of major importance to appreciate the role of crack in soil structure dynamics by climate factors, especially in the agricultural soils under the reduced tillage systems. The compacted soils with horizontally oriented soil crack (Φ) can be regarded as an intermediate stage between compacted (Δ) and well structured (Γ) soil in their dynamics. The stochastic Boolean model for this type of crack is presented in this study using the concept of stochastic geometry. These cracks are assumed to be a line segment with a random length and direction, and their middle points are assumed to follow the spatial Poisson point process. This approach was tested on cracks pattern observed on a cropping system experiment in northern France. . Three cropping systems on a long term experimental station in a loamy soil are managed to present different degree of compaction levels by soil moisture contents at the field. The indices indicating relative areas of each structural feature (ΔsgΓsgnd Φ) proposed by Manichon (1987) and cracks has been measured for 5 years by the soil morphological description method and image analysis used in France to characterize the restructuring process on degraded soils by compaction. In addition, soil morphology, physical, and hydraulic properties (i.e., the structural void ratio, the shear strength, penetration resistance, and water infiltration rate) were also compared among these structural types. The results showed that natural recovery of degraded structural features and physical properties takes many years under reduced tillage. The structural porosity of soils which was once compacted is remained very low during the five following years under reduced tillage. However, the evolution of structure during these 5 years due to climate effect was also identified. This process typically develops the platy soil structure in the upper part of the compacted zones, and consequently, the mechanic and hydraulic properties were also altered. The specified intensity function of the Poisson process representing crack population and spatial behaviour presented the spatial trend of clustering behaviour, corresponding to evolution sequence of structural types. Resulted cracks represented by a line segment show their correlation to climate. The crack directions of soils with the highest compaction level are significantly horizontal and different from those with the least compaction, implying the platy structure. The shear strength of this type of soil decreased quickly, while infiltration rate and penetration resistance remained rather constant. The infiltration rate which was almost zero after compaction, increased quickly after several months but the full recovery took more than one year. These results showed how climate have an influence on soil structure regeneration in the reduced tillage system of this loamy soil.