Spatial characteristics of soil aggregates under different agricultural managements

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Abstract

In agriculture, soil organic matter (SOM) can vary by management type. With the advent of computed microtomography, 3D gray scale scans of whole aggregates can be obtained and used to analyze the distribution of SOM in soil aggregates of different managements. 3D variograms of cubic subsections of scans (n=157) were analyzed for differences in spatial characteristics. There was shown to be a significant difference (α=0.05) in the sill and the slope of a line made from the first three points of the variogram between conventional tillage and two other treatments, indicating conventional tillage management has less spatial variability than the other two treatments.

Keywords: soil organic matter, μCT, soil aggregate.

1. Introduction

An important component of agricultural soil quality is soil organic matter (SOM) content. SOM positively affects soil aggregation, cation exchange, soil water holding capacity, and soil drainage. SOM is believed to be protected and stored within soil aggregates (Six *et al.*, 2000). However, studying the spatial distribution of SOM in aggregates has been very difficult as most current techniques are destructive and often require the whole aggregate as a sample size. The advent of computed micro-tomography (μCT) allows for the *in situ* and non-destructive scanning of soil aggregates (Mooney *et al.*, 2012; Helliwell, *et al.*, 2013). These scans produce gray scale 3D images with gray scale values correlating to different structural components. Since SOM has a lower density than the soil mineral phase, it is typically represented on 3D images as lower gray scale values than mineralogical materials. Thus, SOM distribution with aggregates can potentially be assessed using 3D images from μCT. Different agricultural treatments influence SOM levels. Conventional tillage agriculture is known to have lower SOM content than soil under organic agriculture and soil from natural vegetation (Grandy and Robertson, 2007).

2. Method and Results

This study uses 3D variograms of cubic subsections (n=157) of soil aggregates to determine spatial characteristics of soil aggregates from three different managements

and to assess differences between these managements. Variograms of the soil cubes were fitted using SAS. All cubes were fit with exponential models. Spatial characteristics were compared in SAS using ANOVA statistics. A significant difference (α=0.05) in terms of sill values was observed between the conventional tillage and the other two managements indicating more variability in organic management and natural vegetation compared to conventional tillage. The exponential model did not fit every cube well, specifically near the origin, so a line fitted to the first three points of the variogram was used to better model the variograms' behavior near the origin. The slopes of these lines show a significant difference (α=0.05) between conventional tillage and the other two managements, again indicating more spatial variability in aggregates from organic and natural vegetation treatments.

3. Conclusion

While individual aggregates vary in their spatial characteristics, there is an overall trend in aggregate spatial characteristics between treatments. The sill and slope from the first three points of the aggregate cube variograms show that there is more spatial variability in aggregates from organic agriculture and natural vegetation than in conventional tillage. The cause of this variability is currently unknown.

References

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