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ARECA Soil Health Initiative

This article is part of a series to promote better understanding of our agricultural soil resources along with practices that can influence soil health.

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What does soil structure say about soil health?

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Understanding what constitutes good structure for a particular soil type, along with how farm practices will influence that structure is an important aspect of soil health management. Soil structure describes the arrangement of soil particles into larger clusters, called aggregates. The pattern of soil structure will depend on soil chemistry and texture – the relative proportion of sand, silt and clay particles, along with the various by-products from good soil biology. In fact, aggregation results largely from soil biology acting on the chemistry and texture for any given soil type over time. Soil particles are also aggregated through iron oxides, clays and carbonates with medium to finer textured soil types (higher clay content) generally having more well defined structure.

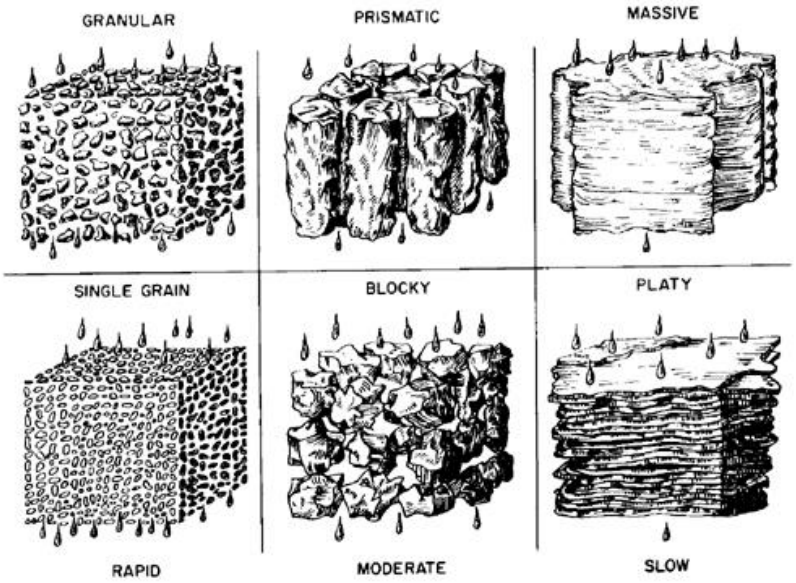
Soil biological activity substantially affects soil structure including the stability of aggregates, soil pore size and the presence of macropores. Having about 50% soil pore space available for air and water holding is a desirable condition for most soil types (measured as the bulk density). Plant rooting action helps with aggregation, along with supplying root exudates and residues that feed soil biota. Earthworms and other burrowing insects like ants help to form stable macropores that encourages water infiltration and air exchange. These, along with other tiny arthropods, produce fecal pellets consisting of mineral and organic material that stabilize aggregates. Likewise, fungi and bacteria produce substances that help cement soil particles – one of which is glomalin, a stable glue-like substance produced by mycorrhizae fungi. Mycorrhizae live in the plant rhizosphere – the soil zone surrounding plant roots, infecting the roots of most plant species in a symbiotic relationship, providing nutrients and other functions in exchange for plant carbon. One teaspoon of a healthy soil is thought to have as much as 10 meters of fungal filaments.

Figure 1 illustrates several common soil structure types. Topsoil from medium to fine textured soil types with good soil biology and minimal tillage will usually develop a crumbly, granular structure comprised of loosely packed aggregates. Subsoil layers will often have larger aggregates that are blocky, prismatic or columnar in shape – depending on texture and chemistry. Soils that are relatively devoid of structure (called 'massive') or having a platy structure are undesirable. Platy structure is an indication of compactness that can restrict root growth and water infiltration. The goal is always to improve structure with biology or soil amendments rather than tillage but there are instances when subsoiling may help to kick start severely compacted soils.

Good soil structure increases porosity, which contributes to water infiltration, water holding capacity, aeration and encourages root development. Practices that help build good soil structure include perennial crops or pasture and diverse no-till or low soil disturbance cropping systems. Disturbance destroys soil structure and impairs soil biology. Maintaining good soil cover and active plant growth as long as possible during the growing season supports soil biology, building structure more quickly. Recycling nutrients where possible with grazing is beneficial but not always practical for most crop rotations. Addition of manure is advantageous if available. Rotation is an advantage because, in addition to cultural control of

pests, it also promotes soil biological diversity, given that each crop species will promote a different spectrum of species within the soil biota. Rotations that include crops with differing rooting patterns will also help build soil structure, like the fibrous root of a cereal and the tap root of a canola or pea. And finally, avoiding traffic – especially when soils are wet, will help to maintain good soil structure.

Figure 1. Soil structure types with their respective water infiltration pattern (courtesy of Colorado State University).



In summary, soil structure describes the pattern of soil particle aggregation and is a critical aspect for soil health. Good structure for any particular soil will depend on other physical and chemical properties like texture and the concentration of SOM and salt types. Improving structure takes time and is driven by good cropping and grazing systems that enhance soil biology, increase SOM and improve soil aggregate patterns.