Soil Clod Test

(USDA-NRCS, 1999; Connelly et al, 2000)

Introduction

Soil structure is the distribution of open (i.e. pore) and closed (i.e. solid filled) spaces. Soil functions such as air and water flow, biological growth, and nutrient cycling are optimized as soil structure becomes more ideal. Ideal soil structure has 50% pore and 50% solid spaces with pore spaces connected to each other and of a variety of shapes and sizes. If this structure is not very stable and easily falls apart upon getting wet (i.e. slakes), then the soil will not be able to maintain these functions. The test below will illustrate if your soil falls apart easily or retains its structure. See Soil Texture Protocol for more information.

Supplies

Boxes or small jars to hold air-dried clods (optional)
Chicken wire/netting/mesh/window screen with openings no bigger than 0.25 inch or 1 cm
Clear container - cylinder/beaker/jar/fishbowl
Labeling tape or sign-making material (optional)
Paper – brown paper/Kraft paper/newspaper
Permanent marker
Soil clods (0.5-3 inches or 1.5-7 cm wide), larger clods are better
Tongs (optional)
Water (Distilled water is preferred but tap is fine)
White paper (optional)

Methods

1. Collect soil clods from soil under different management or areas of the field that differ on levels of productivity. Clods should be collected from the surface to maximum depths of 6 inches or 15 cm and be about the same size.
2. Air dry soil clods by placing them on paper for 5-14 days depending on how wet the clods were as well as the humidity level and temperature where the clods are left to dry.
3. Fill clear container with water to about 0.5 inch or 1.5 cm from the top.
4. Cut chicken wire/mesh to fit into the opening on the top of the container with enough wire/mesh to fit into the opening and reach the water as well as bend over the edge and not fall into in container with the weight of the soil clods.
5. Select air-dried soil clods of the same sizes and place them onto the wire/mesh and observe **(Figure 1A-B)**.
6. Rotate or tap the containers to further break apart the clods and observe **(Figure 1C-D)**.
7. Optional: Rather than placing the soil clods on the mesh, gently drop the clods into the water in the container and observe. Do not do Steps 3-4. Rotate or tap the containers to further break apart the clods and observe.

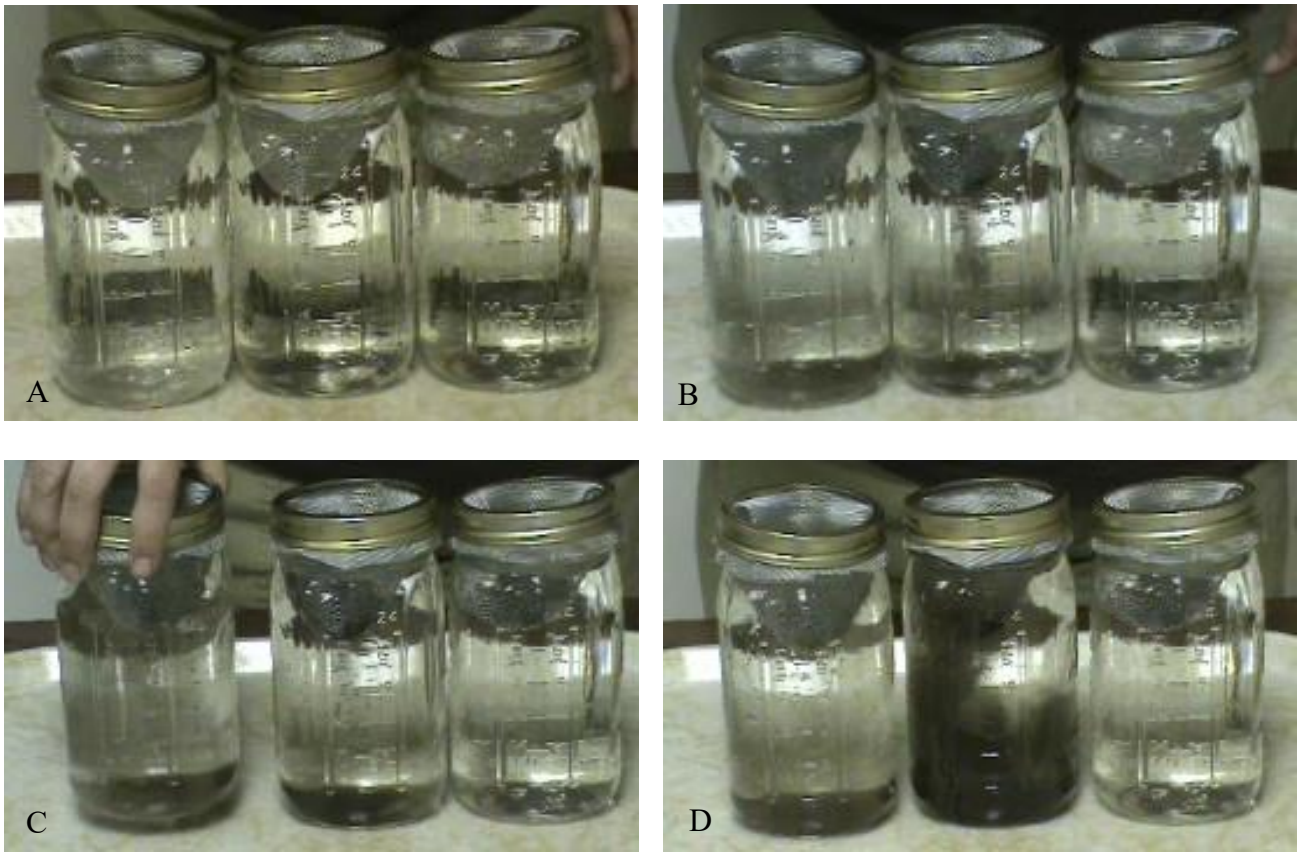

Figure 1. Soil clods from a no-till spring wheat-fallow field, conventional till corn-soybean field, and moderately-grazed pasture (left to right) were added to wire mesh in jars filled with water (A) and the clods started to fall apart (B). After the initial disruption of the soil clods, the jars were rotated (C) and the clods further fell apart (D).

Tips and Tricks

1. Collect soil clods from at least two sites managed differently or under different levels of productivity.
2. Each different set of soil clods should have a different container.
3. Field moist or clods collected the same day may be used, but they do not show differences in management or productivity like air-dried soil clods.
4. After air-drying, any unused soil clods may be stored indefinitely in labeled boxes or jars.
5. Label the clear containers with information about the sites where the soil clods were collecte or write the information on paper and place the paper under or next to the containers.
6. If submerging the clods in water and not placing them on wire/mesh at the top, gently lower them or use tongs if needed.

Observations/What's happening

1. The "healthy" clods largely retain their shapes, while the "unhealthy" clods fall apart.
2. As clods sink or become water-filled on the wire/mesh, observe bubbles coming out of the clods and how quickly and how much of the clods break apart.
3. After time or as the clods reach the bottom of the container, the number of bubbles formed should slow, except in samples that do not have a large amount of stable soil aggregates. See Measuring Soil Aggregation test.
4. Observe the formation of a white or a brown scum layer on the water surface which looks like a soap scum layer. The scum is an indicator of the presence of glomalin (i.e. a biological glue/wax produced by arbuscular mycorrhizal fungi) or other hydrophobins (i.e. water-hating/water-insoluble compounds/substances produced by soil micro-organisms). These compounds/substances are not stabilizing aggregates but may be on fungal hyphae or free in the soil and will float out of the aggregates or soil clods with air bubbles.
5. Initially, bubbles, scum, and fine debris will be released as the air in the pore spaces between aggregates within the clods is replaced by water. In some cases, the scum will appear more brownish than white due to the fine particles within the soil which float to the surface as well or due to iron binding to glomalin in the soil.
6. "Unhealthy" soils contain little, if any, stabilized aggregates. As the bubbles continue to flow out of the clods, the air is coming from these unstable aggregates and the clods will completely fall apart.
7. The bubbles formed after the clod has reached the bottom of the container or after gently shaking are mostly from air trapped within the aggregates. When dry soil gets wet, water rapidly moves into the open space within the aggregates. Air molecules in these open spaces are pushed closer together as the water moves in because the water is denser than the air. As the air molecules get pushed together, pressure starts to build and eventually blows the aggregate apart. Rupturing of the aggregates within a clod causes the clod to break apart. Bubbles are an indicator of that trapped air escaping.
8. If the clod is stabilized by biological glues and waxes described in number 4, the water moves more slowing into the open space which allows the air molecules time to escape and air pressure does not cause tiny volcanic-like explosions to break apart.