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Soil Aggregates- Soil Health Indicator

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What is soil aggregates?

A group of primary soil particles (sand, silt and clay) that cohere to each other by moist clay, organic matter (like roots), gums (from bacteria and fungi) and by fungal hyphae is called soil aggregates."

Importance of soil aggregates

Soil aggregates are important in the formation of soil structure and for soil health. Aggregate stability is important in agriculture since it determines how well an agro ecosystem will work. Well-aggregated soils have a lot of aggregates, and this condition is regarded to be particularly desirable for a variety of reasons. Aggregates are necessary for a variety of basic soil processes, including retaining nutrients and preventing erosion, as well as maintaining root systems and minimizing water stress, provide a home for soil microorganisms, enable for the growth and penetration of plant roots, help in nutrition transportation and cycling. The spaces between soil particles and soil aggregates are known as soil pores. Air and water storage, as well as gaseous exchange, are influenced by the pore spaces in soil. Erosion is less likely in soils with a high aggregate stability. When stable aggregate subjected to disruptive forces such as water, they maintain their shape and do not easily disintegrate.

These aggregates are clumps of soil that range in size from micro (less than 0.25 mm in diameter) to macro (more than 0.25 mm in diameter) (greater than 0.25 mm in diameter) each class having specific benefits for soil health. Organic components bind silt and clay particles together form micro aggregates. This results in the formation of a long-term organic matter pool. Macro aggregates are made up of silt/clay particles, micro aggregates, and organic components. Plant roots, mycorrhizae, and earthworms all play a part in the creation of macro aggregates. These larger aggregates decompose more quickly, supplying organic

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materials to roots, bacteria, and fungi. Because of the wide soil pores, water can easily permeate the soil.

Practices that lead to poor aggregate stability include:

- Tillage methods and soil disturbance activities that breakdown plant organic matter, prevent accumulation of soil organic matter, and disrupt existing aggregates,
- Cropping, grazing, or other production systems that leave soil bare and expose it to the physical impact of raindrops or wind-blown soil particles,
- Removing sources of organic matter and surface roughness by burning, harvesting or otherwise removing crop residues,
- Using pesticides harmful to beneficial soil microorganisms.

Managing Soil Aggregates

1. **Reduced or no-till systems-** The level of soil aggregation is directly influenced by management approaches. Reduced or no-till systems enhance aggregation, whereas high-intensity tillage practices inhibit aggregation. Tilling breaks up macro aggregates, which limits their production and leaves microscopic soil particles behind. This closes pore spaces and makes it difficult for water to penetrate the soil. Minimal tillage, for example, minimizes soil disturbance and promotes the establishment of micro aggregates within macro aggregates, resulting in long-term carbon and organic matter storage."
2. **Cover Crops-** It's critical to keep soil covered in order to keep it intact. The impact of erosive forces on the soil is reduced by vegetative cover. By limiting evaporation and increasing water infiltration, a cover crop mulch can improve moisture availability. Cover crop residue aids in weed control, which is especially crucial in organic no-till farming.
3. **Cropping diversification**- Promoting a cropping diversification. Perennial plants and meadows have extensive root systems and do not require tillage. The dense, fibrous, rooting system of perennial grasses and shallow-rooted legumes creates a very active biological zone near the surface.
4. **Grazing management**- Grasses have strong root systems, but over grazing by animals can disturb the forage chain. There are numerous techniques to graze animals while maintaining or improving soil stability.

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5. **Crop rotation**- Crop rotation means changing the type of crop grown on a particular piece of land from year to year. Legumes (and their rhizobial partners) promote aggregation by producing binding agents. On the other hand, legumes have a less fibrous root architecture than grasses, which are linked to more macro aggregation in the topsoil. A higher root length density (length of roots per volume of soil) than, resulting in stronger, denser, and more stable soil macro aggregates loaded in SOC. When exposed to erosive forces, poorly aggregated soils disintegrate quickly.
6. **Increase soil organic matter content**- Organic matter is broken down by soil organisms. When these organisms break down, they emit organic substances which act as the "glue" that binds soil aggregates. A polysaccharide is an organic substance released into the soil by microbes and roots that are made up of several simple carbon compounds linked together in a long chain that can make contact with many soil particles and is linked to the formation of aggregates.
7. **Soil microorganism**- Soil microorganism plays an important role in maintaining structure and health. Fungi form nets rather than glues. These networks of fungal is called mycelia (the organism's vegetative portions) binds small aggregates together and forms large aggregates. Macro aggregates are kept together by fungal hyphae, which drive vital biological activity in the root zone, much like micro aggregates are held together by microbial glue. Fungal hyphae and fine roots are essential for minimizing erosion, physically protecting aggregates, and keeping soil in your field where it belongs. Bacteria produce EPS, which is a slimy polymer secreted by bacteria (extracellular polymeric substances). These can operate as stronger soil glues, create aggregate and keeping soil moisture levels stable. Plant roots continuously release organic substance into the soil in the rhizosphere which is called root exudates. Exudates provide food for the microorganisms, in addition to assisting plants in obtaining nutrients. Exudates act on the micro level, whereas roots and fungi in the soil hold bigger clumps of soil together. They bind soil particles together in critical mechanical networks, much like glue. Exudates' influence on the soil can be transitory, whereas the binding actions of roots and fungal networks are usually long-term. Microbes consume and convert root exudates, thus they don't persist long in the

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soil in their natural state." The addition of organic materials improves the aggregate's strength and stability.

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