UNIVERSITY OF DELAWARE
COOPERATIVE EXTENSION

Delmarva Soil Types and Potential Salinity Impacts

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Soils and Salinity Effects

Salts are compounds formed when positively charged cations such as sodium (Na^+), calcium (Ca^{2+}), magnesium (Mg^{2+}) and potassium (K^+) combine with negatively charged anions like chloride (Cl^-), carbonate (CO_3^{2-}), boron ($B(OH)_4$-), and bicarbonate (HCO_3^-). In soil systems, salts originate from weathering of parent minerals, fertilization application, and irrigation with water containing dissolved salts. As salt concentrations increase in the soil, they influence both soil properties and plant growth.

Salts and Cation Exchange Capacity

Many of the salts mentioned above are essential plant nutrients and natural components of all soils. They are held by the soil's cation exchange capacity (CEC), which represents its negative charge and ability to attract cations like Ca, Mg, K, and Na. In the acidic soils of the Delmarva Peninsula, hydrogen (H^+) and aluminum (Al^{3+}) also occupy CEC sites. Soils with higher clay or organic matter content have greater CEC, providing higher buffering capacity and retaining more salts without immediate visible effects.

This characteristic is crucial when soils receive excessive salts. Cations held on the CEC are gradually released as plants absorb them, maintaining a lower concentration in the pore water. However, during events like tidal flooding, excess salts surpass the soil's holding capacity, saturating pore water and negatively impacting plant growth and soil properties. In well drained Delmarva soils, these salts will be prone to leaching, but these low-lying areas of the field will have limited leaching potential, leading to salt accumulation.

How Do Salts Affect Soils?

Soil structure refers to the bonding of soil particles to form shapes (flocculation), such as the granular or blocky structure shown in Figure 1. Moderate levels of cations (particularly Ca) can promote flocculation, improving aeration, root penetration, and overall soil structure. However, high concentrations of sodium (Na) can lead to soil dispersion, causing clay particles to swell and separate, as illustrated in Figure 1c.

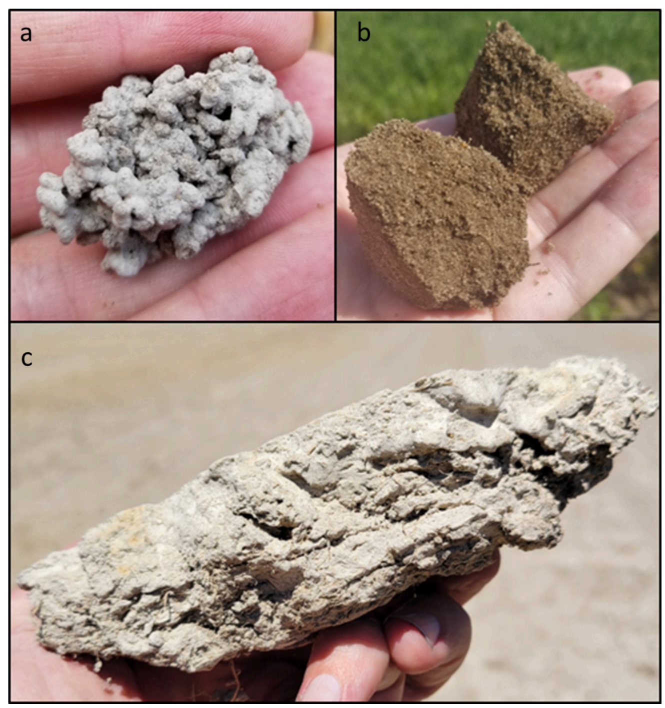

Figure 1: Soil aggregates forming a) granular structure due to earthworm castings, b) weak blocky structure in sand, and c) massive structure in salinity-affected silt loams. Photos courtesy: Jarrod Miller

This dispersion disrupts soil water movement by clogging pore spaces, reducing water infiltration and limiting air movement for plant roots. Over time, repeated cycles of wetting and drying can form surface crusts, further restricting water penetration, air exchange, and root growth. As a result, high sodium levels degrade soil quality, hindering healthy plant development. Remediation of these soils requires substantial gypsum application (Ca source) to replace Na on the CEC and restore proper soil function. However, leaching of Na must also occur for this to be effective.

General Soil Types of Delmarva

The Quaternary-age surface deposits of the Delmarva Peninsula, consisting of unconsolidated near-shore marine and estuarine sediments (Markewich et al., 1987), have significantly influenced the region's soil characteristics. While the soils are predominantly **sandy**, reflecting their coastal origins, they may also be buried under **silty** loess deposits, increasing the diversity of soil textures across the area (Figure 2).

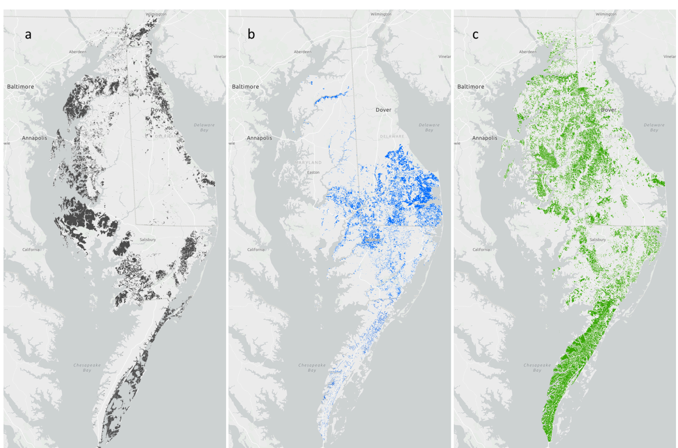

Figure 2: Map of the Delmarva Peninsula showing a few soil series with surface textures of a) silt loam, b) loamy sand, and c) sandy loam, particularly along the coastline (SSURGO).

The Delmarva Peninsula has been shaped by two loess deposits: the older Miles Point loess, covering 133,000 acres, and the newer Paw Paw loess, covering 1,235,000 acres (Wah et al., 2018). The Miles Point loess, with a high silt content (>56%), extends from Dorchester to Queen Anne's County, MD, and ranges in thickness from 63 to 188 cm. The Paw Paw loess, once covering the entire western peninsula, has been significantly eroded and is now less than 2 meters thick, thinning from west to east and north to south.

Loess deposition is concentrated along the Chesapeake Bay shoreline, contributing to the silt loam textures in the area (Figure 2a). Soil series with these features on Delmarva include Othello or Elkton series, with loess-derived silt loam surfaces and sandier materials beneath (Figure 3). For example, the Othello series has very low sand content to depths of around 3 feet (100 cm), where there is a sharp increase in sand content. Similar deposits along the Delaware Bay shore in New Castle and Kent counties, DE, producing silt loam textures (Figure 2a).

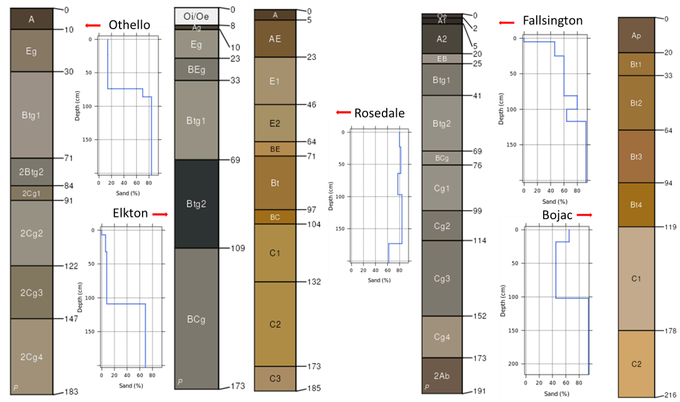

Figure 3: Delmarva soil series profiles that include silt loam (Othello, Elkton), loamy sand (Rosedale), and sandy loam (Fallsington, Bojac) surface textures. Graphs show sand content (%), being greater as you move right on the x-axis (UC Davis Soil Web).

This loess also contributes to the sandy loam textures in central Delaware (Figure 2c), which could include soil series such as Fallsington (Figure 3, fourth profile). Sandy loams are also mapped along the Atlantic Maryland shore and predominate as the Bojac (Figure 3, last profile) series on Virginia's Eastern Shore.

In areas without loess, loamy sand textures dominate, particularly in Sussex County, DE, the southernmost part of the state. An example would be the Rosedale series, found in southern Delaware, which is sandy throughout the profile (Figure 3, middle profile).

Potential Salt Effects on Delmarva Soils

Low-lying coastal areas on both the Chesapeake Bay and Atlantic Ocean sides of the Delmarva Peninsula face high saltwater intrusion risk due to low elevation, extensive shorelines, and tidal proximity. Chesapeake Bay's tributaries, estuaries, wetlands, and ditch drainage systems provide pathways for saltwater to move inland, especially during high tides, storms, or droughts when freshwater flow is reduced. Agricultural areas with ditch drainage are particularly vulnerable. However, effects vary regionally due to differences in soil texture.

Silt loam soils, with a higher silt proportion, help buffer against salinity. In South Dakota, sandy loam soils caused greater yield declines under saline conditions than silty clay loams (Butcher et al., 2018). Thus, soils along the Chesapeake and northern Delaware Bay may tolerate more salinity. However, high salt levels from brackish water can cause soil dispersion (Figure 1c), particularly in soils with loess caps. Soil series like Othello and Elkton have high silt content down to 70 cm, which may limit salt leaching. Below this depth, increased sand content raises permeability. In Maryland, counties with silt loam soils facing significant saltwater intrusion risks include Dorchester, Somerset, Talbot, Queen Anne's, Kent, and Worcester. Their low elevation, tidal proximity, and ditch drainage systems increase susceptibility.

From Sussex County, DE, to the Eastern Shore of Virginia, sandier soils present variable challenges. Sandy loam and loamy sand soils, like Bojac and Rosedale, are highly permeable, allowing rapid water and salt movement. While they have less buffering capacity against salts, they are also less prone to the formation of massive structures. The primary concern is their limited ability to retain nutrients and mitigate salinity effects on plant growth. Due to their low water-holding capacity, crops grown in loamy sand may experience more frequent stress from salinity, as the soil cannot retain enough moisture to dilute or leach away salts effectively.

As saltwater intrusion continues to threaten coastal agricultural lands, understanding how soil texture influences salinity resilience is critical. While silt loam soils may offer some buffering capacity, sandier soils are more vulnerable due to their high permeability and limited nutrient retention. The combination of low elevation, tidal proximity, and drainage infrastructure further amplifies risks across the Delmarva Peninsula. Future management strategies must account for these soil differences to mitigate the long-term impacts of salt exposure on crop production and soil health.

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Reviewed by: Phillip King, DC/MD/DE State Soil Scientist

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