Calcareous Soils In Miami-Dade County[1]

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Calcareous soils in Miami-Dade County are derived from Miami limestone. This surface rock blankets nearly all of Miami-Dade County, part of Broward County, and Monroe County (including the Florida Keys), and has a maximum thickness of about 33 feet (12 m). There are two kinds of calcareous soils in Miami-Dade County: *rocky* or *gravelly soils* and *marl soils*.

Rocky Soils

Rocky soils exist in rocky pinelands of south Florida. Elevations here range from 5–20 feet (1.5–6 m) above sea level. Drainage is rapid through the soil and underlying bedrock down to the water table. Percolating waters have dissolved parts of the bedrock to form numerous holes and small cavities called "solution holes." These solution holes are filled with gray, brown, or reddish sandy loam or clay loam soil. Pineland vegetation is mainly slash pine, saw palmetto, subtropical shrubs, wiregrass, switchgrass, and a scattering of oaks and other hardwood trees.

Pioneers in the area used these rocky pinelands for housing and farming because of their relatively high elevations. They planted vegetables and fruit trees more or less at random in large solution holes or "pot holes." Years later, after the land had been cleared, they used dynamite to blast small holes in the limestone for planting. Rock plowing was introduced in the early 1950s. A scarifying plow front-mounted on a large bulldozer crushes the oolitic limestone bedrock to a depth of 6–8 inches (15–20 cm). Rollout from the plow's cut passes beneath the treads of the tractor, crushing the rock slice into small pieces and mixing them with the natural soil components to form new soil. After this operation, scarified soils are deep enough for growing vegetable crops. For growing tree crops, growers have found it beneficial to create soil-filled trenches another 10–20 inches (25–50 cm) deep in the bedrock beneath the rock-plowed surface layer. The trenches are dug in parallel lines for the tree rows in the future grove. Another set of parallel trenches, perpendicular to the first, is dug for spacing the trees within each row. Where the two trenches intersect, a tree is planted. In this way, groves of tree crops such as limes, avocadoes, mangoes, and lychees are established.

These rock-plowed soils have very gravelly textures (34%–76% limestone fragments, 2 mm or larger in diameter), and their organic content is usually less than 2 percent. A typical gravelly soil was classified in the 1996 soil survey as Krome soil (Loamy-skeletal, carbonatic, hypothermic Lithic Udorthents). However, non-rock-plowed rocky pineland soils had been classified as Rockdale in 1958 soil survey, and these were not included in 1996 soil survey.

Marl Soils

Marl soils cover low lying lands in south Florida, mainly in Miami-Dade and Monroe Counties, including Everglades National Park. Mineralogical analyses have indicated that almost 100% of the soil minerals are calcite that had precipitated from water saturated with calcium bicarbonate. During the annual wet season when these lands are flooded, several hundred species of microalgae (periphyton) grow on the surface water. They are the primary cause of precipitation of calcite. After a certain depth of soil has

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formed on the bedrock, vascular plants become established on this primary marl soil. Plant growth in the area further stimulates formation of marl. Plant roots release organic acids (such as citric acid) to the rhizosphere. These organic acids react with the bedrock, and dissolve it to increase the concentration of calcium (Ca) ions in the soil solution or in the surface water. Plant litter fall; other dead plant materials and dead algal cells progressively increase the organic matter content.

Marl is formed when the land is flooded for several months each year in the summer (hydroperiod), followed by a number of dry months during the winter. The hydroperiod in marl forming areas is shorter than in peat forming areas. Flooding creates anaerobic conditions and increases the accumulation of organic matter. During the dry period, this organic matter is oxidized. The relative lengths of the dry and wet periods determine the accumulation rates of organic matter in marl soils. Organic carbon content in natural marl soils ranges from 10–30%. The rate of calcite mud (marl) deposition in the present coastal areas, as measured by radiocarbon dating, has averaged 1.2 cm/100 years from 1000 years ago to the present. Generally marl soils form a layer 2 to 72 inches (5–183 cm) thick above the limestone bedrock.

Drainage of marl soils is poor or very poor. The native climax vegetation is mainly sawgrass, switchgrass, needle-grass, reedgrass, various sedge, reeds, mimosa, buttonwood, and black mangrove. Such plant communities can now be found only in the Everglades National Park. Most of the marl soils in Miami-Dade and Monroe Counties are affected by the modern drainage system. Moreover they have been tilled in order to grow winter vegetables, tropical fruits and field-grown ornamental crops. In the 1996 soil survey, a typical marl soil was classified as Biscayne soil (Loamy, carbonatic, hyperthermic, shallow Typic Fluvaquents).

Management of Calcareous Soils

The marl and rocky calcareous soils in Miami-Dade County usually contain from 30% to 94% $CaCO_3$. The pH values of calcareous soils are greater than 7, usually in the range of 7.4–8.4. Textures of calcareous soils can be sandy, loamy or gravelly. Soil depths range from less than five inches to several feet. These soils are important for production of vegetable, fruit, and ornamental plants in Florida. Over 85% of Florida's tropical fruits are grown on calcareous soils in the southern part of the state. This is done because of favorable temperatures, rather than favorable soil characteristics. Careful management of nutrients is critically important to the successful production of crops on calcareous soils. The following information is likely to be useful for commercial growers and homeowners, who grow plants in Miami-Dade County.

Acidification of calcareous soils: Growers often ask whether they should use soil acidulents such as elemental sulfur (S), sulfuric acid, triosulfate salts, etc., to acidify the calcareous soil. To date no research data have been generated to establish a beneficial effect of applications of any acidic products on calcareous soils in Florida.

Nitrogen (N): The loss of nitrogen through the volatilization of ammonia is significant for ammonium N fertilizer applied on calcareous soils. Ammonium N fertilizer should be incorporated or introduced into the soil through irrigation. Also, nitrate N fertilizer is readily leached through gravelly calcareous soils, as a result of over-irrigation or heavy rainfall.

Phosphorus (P): Phosphorous fertilizers applied in calcareous soils are fixed by calcium carbonate (calcite) through adsorption and precipitation. Consequently, the availability of P in calcareous soils is relatively low. However, repeated applications of large amounts of P fertilizer results in the accumulation of P in most cultivated calcareous soils. Accumulated P is slowly released into the soil solution to become available to plant roots. Therefore, growers should use less P fertilizer if their soils already have high residual P.

Potassium (K): Potassium deficiency is not common for crops grown in calcareous soils in Miami-Dade County. However, K is readily leached out of the root zone in sandy or gravelly soils. Therefore, split applications of K fertilizer are recommended.

Calcium (Ca): Calcareous soils have an abundance of calcium available for plant uptake. Application of calcium fertilizer is not necessary.

Magnesium (Mg): Although Mg concentrations in calcareous soils are not low, crops grown on calcareous soils often show Mg deficiency symptoms. The high calcium concentrations in calcareous soils suppress Mg plant uptake and its translocation from the roots to the upper plant parts. Magnesium can be applied as a dry fertilizer or as a foliar application. Foliar applications of magnesium nitrate and magnesium sulfate have been shown to be efficacious.

Iron (Fe): Iron chlorosis is the most frequent nutritional disorder encountered in crops grown on calcareous soils. Inorganic forms of Fe in calcareous soils are largely or almost totally unavailable for plant uptake. High concentrations of bicarbonate in the soil solution can prevent Fe uptake by the plant, as well as its translocation within the plant. Most fruit crops are susceptible to Fe deficiency. Chelated Fe (Fe-EDDHA) is commonly used for fruit trees. On the other hand, most vegetable crops commonly grown on calcareous soils in Florida have been selected for good adaptation to high pH soils. Thus, vegetable crops generally do not suffer from Fe deficiency. Some iron-efficient crops release organic acids from their roots to neutralize the bicarbonate and to mobilize soil Fe. Other iron-efficient crops possess high Fe-reductase activity, or other superior physiological and biochemical characteristics. Application of EDDHA chelated Fe is commonly practiced to improve the Fe nutrition of both fruit and vegetable crops. Generally, it is applied as a soil drench (water plus iron) or through the microirrigation system (fertigation).

Zinc (Zn) and Manganese (Mn): The solubilities and availabilities of Zn and Mn are very low in calcareous soils. However, most vegetable crops have the ability to take up sufficient quantities of both Zn and Mn. Applications of fungicides containing Zn and Mn also provide available Zn and Mn to plants. Nevertheless, deficiencies of Zn and Mn are very common in crops grown on calcareous soils. Foliar applications with Zn and Mn fertilizers can effectively correct these deficiencies.