

Vegetarian Newsletter

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Eat your Veggies!!!!

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Managing pH of Muck Soils for Vegetable Production

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Historically, the Everglades Agricultural Area (EAA) evolved under seasonally-flooded conditions that predominately supported sawgrass and other wetland vegetation. Over several thousand years, Histosol “muck” soils were deposited as organic matter accumulated above the limestone (calcium carbonate) bedrock. In the early 1900s, these soils were drained. Declining water table levels coupled with increased urban development and agricultural activities initiated muck oxidation, soil compaction, promotion of muck fires, and increased potential for soil loss due to wind erosion. These factors have led to decreases in soil depth above the bedrock limestone, a phenomena commonly referred to as subsidence.

When these soils were initially drained, soil pH values were lower than they are now. Most organic soils typically reflect acidic soil pH values ranging from 4.5 to 5.5. Current soil pH values in the EAA for shallow muck soils are considerably higher, ranging from 6.5 to 8.5, although soil pH is spatially variable.

As a consequence of field operations to prepare crop lands, tillage efforts for weed control, incorporation of fertilizers, and planting, as well as subsurface irrigation, high pH particles of calcium carbonate (originating from the bedrock) are transported from the subsurface into the root zone (Figure 1). Since calcium carbonate is the source of agricultural lime, tillage of shallow muck soils is effectively liming the soil. This tillage-induced transport is more problematic for many of the shallow soils less than 2 feet in depth. Additionally, carbonates dissolved in water can move up in the soil profile due to capillary action, and are often deposited at or near the soil surface after water is evaporated. Evidence of this effect can be observed by the white crust formation on the soil surface during drying weather conditions, which is a combination of calcium carbonate and calcium sulfate.

Nutrient Availability

Organic soils within the EAA formed as oligotrophic wetlands, meaning that most nutrient concentrations were commonly deficient for growth of plants other than the native vegetation. This deficiency is readily observed for phosphorus and micronutrients, such as manganese, copper, and zinc. Early research demonstrated that application of these nutrients as fertilizers significantly increased crop growth and yield. However, required rates of fertilizer application to support favorable crop growth responses have increased with time, corresponding with decreasing soil depth and increasing pH. Clearly, crop nutrient requirements have also increased over time due to the adoption of modern-day cultivars that have significantly greater growth potentials.

Most micronutrients and P are readily available to vegetables at lower acidic soil pH values. Phosphorus and micronutrient availability to crops typically declines as soil pH values increase into the higher ranges characterizing current EAA muck soils. Due to increases in soil pH in the EAA, the problem is not so much that total concentrations of nutrients are low but rather that the availability of these soil nutrients to crops is too low. Thus, the current situation is that muck soils are increasingly developing soil chemical conditions that compromise the availability of applied fertilizer nutrients for crop growth.

How to Address the pH Problem

There are several practical ways to address the problem of increasing soil pH. One way is to add an acid-forming amendment to reduce the pH, resulting in increased nutrient availability. Another strategy is to adopt improved fertilizer management practices, such as improved timing, placement, split applications of fertilizers, and use of slow-release fertilizers. Modified cultural practices, such as a reduction in the number and intensity of tillage operations, may attenuate the vertical movement of calcium carbonate through the soil profile, and could likely be attractive due to reduced energy costs. Reductions in the rate of soil subsidence by flooding of fields during fallow will also help to decrease soil pH. It is likely that stabilizing the water table will slow the movement of solubilized calcium carbonate upward with capillary water movement.

Soil pH Adjustment

A common method to reduce soil pH in the EAA is the application of elemental sulfur. When mixed into soil, sulfur-oxidizing microorganisms utilize the sulfur and convert it to sulfate, and in the process, generate acid-forming hydrogen ions which decrease the soil pH. However, depending on the buffering capacity of the soil, large quantities of sulfur are often needed to effect a change in pH. The routine use of sulfur to reduce soil pH across large field areas is improbable since the large amounts that would be required annually would simply be cost-prohibitive. This statement is especially true considering the large amounts of calcium carbonate present in EAA soils that can potentially buffer or neutralize the acidifying effects of sulfur addition.

Strategic banding of sulfur near the plant row is an effective means of adding considerably less sulfur while improving nutrient availability in sufficient soil volume to satisfy immediate crop nutrient requirements for phosphorus and micronutrients. Applying sulfur primarily in problematic (high soil pH hotspots) areas such as along field ditches and near roadways, where calcium carbonate ditch spoils accumulate, is a successful practice that is used for sugarcane in the EAA. These precise placement techniques result in low sulfur application rates.

Fertilizer Management Practices

Fertilizer management strategies can be used to avoid or minimize nutritional problems associated with increasing soil pH. One option is to just increase total fertilizer application rates to overcome nutrient availability limitations. However, rising fertilizer costs and the desire by growers to impart good land stewardship in areas near sensitive wetlands makes this option unattractive.

Banding of fertilizers has been recognized as an effective practice that supports lower fertilizer application rates while maintaining economically attractive vegetable crop yields. The use of banding techniques is even more important given the previous discussion on changing soil chemistry conditions. Currently, a popular “banding” strategy is to band-apply fertilizer sources in a band 1-2 feet wide during vegetable bed preparation, with the fertilizer band incorporated into the bed profile, with the expectation that roots will be able to utilize these fertilizers more efficiently than fertilizers broadcast across the entire field. More precise application methods such as utilization of narrow bands of fertilizer should minimize direct contact of fertilizers with soil, while maintaining higher plant-available nutrient concentrations for the longest period of time.

Another potential strategy is the split-application of fertilizers, which would also reduce nutrient fixation to soil particles and increase potential nutrient availability for different crop growth stages, and adapt to open bed operation. The timing of applications would be more time-consuming and require additional trips through the field, increasing fuel and equipment costs, but may ultimately reduce the total amount of fertilizer necessary to produce crops. With the increasing costs of fertilizers, especially in combination with reduced tillage trips, the expanded use of split applications may prove viable in the future.

Most P fertilizers for vegetables grown in muck soils are soil-applied at planting, which has proven reliable in the past. However, another management option that could avoid nutrient deficiencies brought about by increasing soil pH trends is to expand the use of foliar application. Many micronutrients are currently applied via foliar application, especially for vegetable crops. Since soil-applied nutrients are increasingly rendered unavailable due to rising soil pH, their application directly to crop canopies may be a viable option in the future.

The use of slow-release fertilizers (SRF) has not received much attention in the EAA in the past due to their high costs relative to traditional fertilizer sources. However, SRFs offer potential benefits including the slow-release of nutrients, which minimizes their fixation to soil particles and thus increases nutrient availability for crop growth. The disadvantage of the relatively higher cost for this type of fertilizer can be offset somewhat by the lower rates of slow-release

fertilizers that may be required. The result of wide-spread use of SRFs may also include a potential reduction in the total amount of fertilizers applied to EAA soils, which would be consistent with region-wide efforts to reduce the export of phosphorus and other nutrients into waterways entering the Everglades wetlands while still supporting required commercial yields and market quality.