

2009 Elba Muck Soil Nutrient Survey Results Summary, Part I of III: Organic Matter and pH

Christy Hoepting, Cornell Cooperative Extension Vegetable Program

Elba muck land found to be a source for high nutrient loading into watershed

The Oak Orchard Creek, located in Orleans and Genesee Counties, home of the Elba muck land, is on New York State's list of impaired water bodies according to "303(d)" of the 1972 Clean Water Act and does not meet state water quality standards. In a study conducted by the Orleans County Soil and Water Conservation District (SWCD) and SUNY Brockport, the location and intensity of pollution sources in the Oak Orchard water shed were identified.

The Elba muck land was identified as one of eight major sources of pollution in the Oak Orchard watershed delivering elevated levels of total phosphorus (eg. 5 to 12 mg/L), soluble reactive phosphorus (eg. 1 to 2 mg P/L), soluble nitrate (eg. 3 to 28 mg/L) and total nitrate (eg. as high as 37 mg N/L). As a point of reference, the EPA maximum contaminant level of nitrate-nitrogen (NO₃-N) for drinking water is 10 mg/L. In 30 years of analyzing water samples, the scientists at SUNY Brockport had never seen nitrate levels so high! Too much phosphorus in the water encourages growth of green algae, which causes eutrophication of lakes. In turn, when bacteria eat the algae, they use up dissolved oxygen, suffocating fish and other aquatic life. Water that has more than 0.1 mg/L of total phosphorus is considered highly eutrophic.

Muck soil nutrient survey in Elba muck land, spring 2009

The SWCDs of Orleans and Genesee counties were awarded funding from the federal Environmental Protection Agency (EPA) to provide free soil nutrient tests to Elba muck land growers. The objective of this project was to encourage muck growers to apply only the needed amounts of fertilizer in hopes of reducing nutrient loading into the Oak Orchard water shed.

In the spring of 2009, SWCD worked with 8 growers and sampled 21 "fields" or "blocks" which were approximately 10, 25, 50 or 100 acres in size, and often consisted of several fields. Two to 20 sub-samples were taken per "field/block" for a total of 160 sub-samples. Samples were analyzed by the Cornell Nutrient Analysis Laboratory (CNAL).

All of these soil test results were summarized by Christy Hoepting, Onion Specialist, Cornell Cooperative Extension Vegetable Program (CCE-VP). In addition to phosphorus and nitrogen, all information from the soil tests including organic matter, pH, potassium, calcium, magnesium and micronutrients, were reviewed and opportunities for improved nutrient management for onion production suggested. It is hoped that this will mark the beginning of collaborative efforts among onion growers, CCE-VP, SWCDs and EPA to reduce nutrient loading into the Oak Orchard and other water sheds, but also to improve onion yield and profitability by optimizing nutrient management, applying only what is needed for maximum yields.

Organic matter ranged from high to low – implications for different management practices

Officially, a muck or organic soil is defined as one that contains more than 20% and up to 80 % or more organic matter (OM). Muck soils are a non-renewable resource that was developed

underwater by many generations of plants that were preserved under anaerobic conditions. It takes nature about 500 years to accumulate one foot of muck soil.

In the 2009 Elba muck land survey, the majority (77%) of the 160 sub-samples had more than 40% OM with the highest being 58% (data not shown). It was surprising that at least some of the samples did not have higher OM content. Nine percent of the sub-samples had OM between 20 and 40%, while 13% had less than 20% OM with the lowest reading being 2.4%. These soils, although labeled on the county soil survey maps as muck, technically are no longer muck soil. Generally, fields with such low OM are no longer used to grow onions, although one of them was cropped to onions in 2009.

In this study, there was a correlation between OM and pH; as OM decreased, pH increased (Figure 1). Muck soils are prone to subsidence, which is the permanent lowering of the surface elevation, a phenomenon resulting from the oxidation of soil organic matter by aerobic microorganisms, and by wind and water erosion. As areas of the Elba muck land become shallower, the underlying marl (free calcium carbonate), originally deposited from alkaline (pH greater than 7.0) glacial till, is gradually mixed in with the muck, eventually raising the pH of the soil. As pH increases, the availability of nutrients shifts. Thus, “shallow” mucks with low OM and high pH need to be managed differently than “deep” mucks with high OM and normal pH.

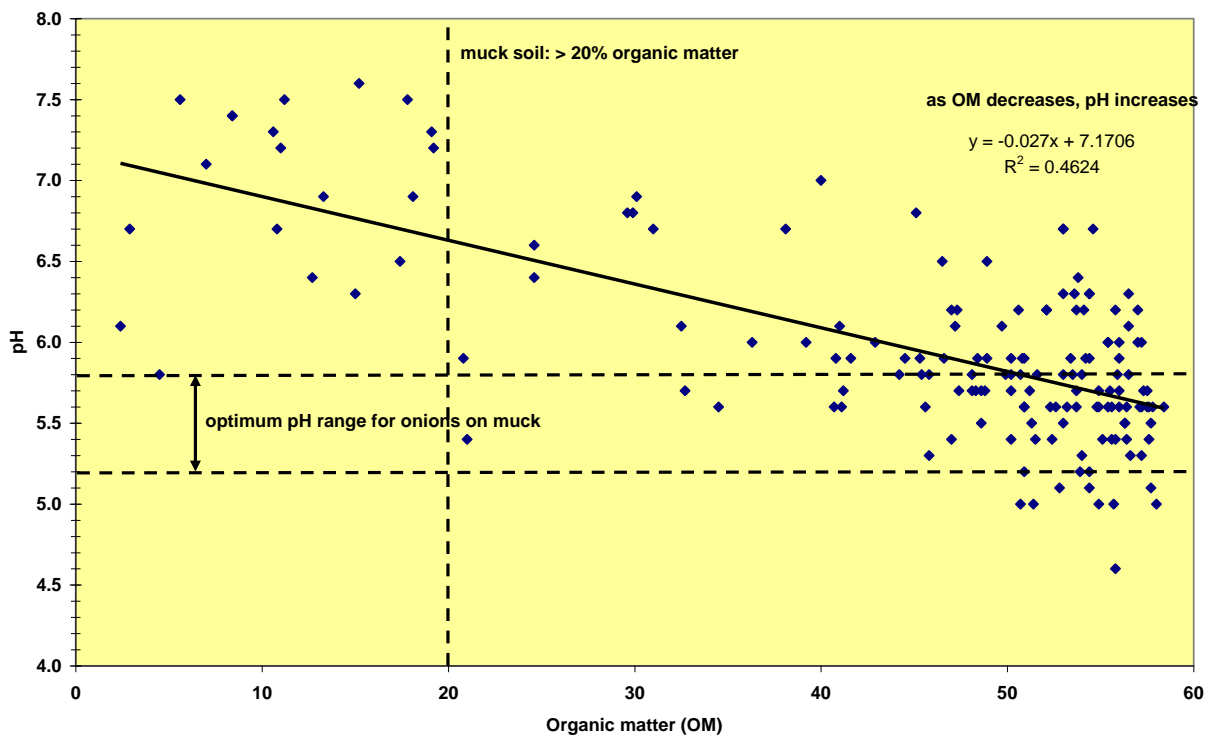


Figure 1. Soil survey, Elba muck, Spring 2009: Relationship between pH and organic matter of 160 individual soil samples.

Elba muck land shifting towards higher pH

The optimum soil pH for onions grown in muck soils is 5.2 to 5.8. Below 5.2, nitrogen (N) and phosphorus (P) can be tied up, while iron (Fe), aluminum (Al) and manganese (Mn) become more soluble and can reach toxic levels. Below pH 5.0, root growth is adversely affected and the

roots' ability to take up water and nutrients is decreased. Above pH 5.8 to 6.0, Mn, zinc (Zn), boron (B) and P are tied up and can become deficient.

In this study, only 35% of the fields/blocks fell into the optimum pH range. However, 45% of the 160 sub-samples fell within the optimum range (Figure 2). The reason that fewer fields/blocks had optimum pH than sub-samples was because individual sub-samples that were above or below optimum pH pulled the field/block averages up or down, respectively. It was not uncommon in this study for sub-samples within a field/block to differ by 1.0 pH units or more. The majority (65%) of the fields/blocks had pH higher than the optimum and 20% had pH between 6.7 and 7.3. The highest pH recorded in a single sub-sample was 7.6! Although none of the field/block averages had pH lower than 5.2, 11 (7%) of the 160 sub-samples did, with the lowest pH recorded being 4.6.

As muck subsidizes growers end up farming deeper layers which may have drastically different pH than the soil they were originally farming. Soil pH will rise as you get closer to calcareous marl, and will fall as you get into orange acidic peat. By itself, oxidation of muck, with resultant loss in organic matter results in higher calcium (Ca) and magnesium (Mg) levels and higher pH. Marly materials from spoil banks can also contribute to an increase in pH along field edges. Since the Elba muck has been farmed for 90 years or more, it is not surprising that there has been a shift towards the soils having a higher pH. Often, patches of shallower muck with higher pHs occur within a field that has otherwise optimum pH. It may be well worthwhile to sample these patches separately, and manage accordingly.

It is important to note that of the 116 sub-samples where OM was greater than 40%, 41 or 35% had pH greater than 5.8 (Figure 1). Thus, increased pH beyond what is optimum for growing onions on muck is not just a concern where the muck is "shallow" and OM is lower, but can occur on "deep" muck as well.

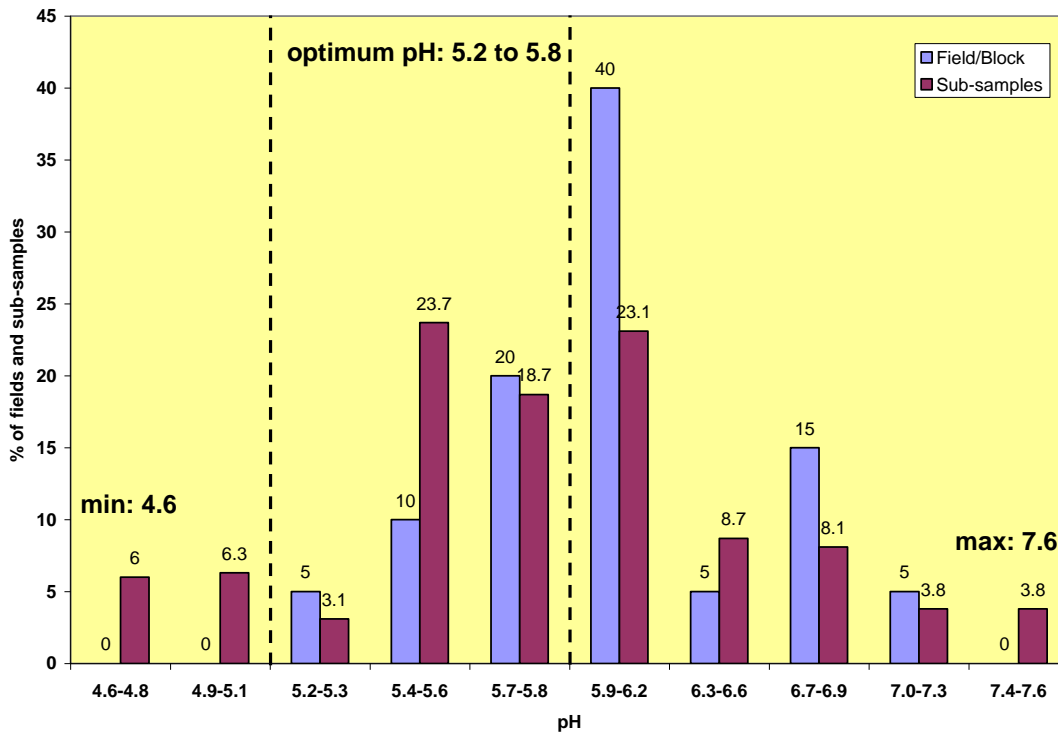


Figure 2. Soil survey, Elba muck, Spring 2009: pH of 21 fields/blocks and 160 sub-samples.

How to increase soil pH

When soil pH falls below 5.5, especially if there is substantial extractable Fe and Al, lime may be added to increase the soil pH. As a general guideline, 1000 lbs of lime are required to raise the pH of muck 0.1 units, which is based on an 8 inch plow layer. If the plow depth is less than 8 inches, decrease the rate of lime by 12% for each inch less than 8. If the plow depth is deeper than 8 inches, increase the rate of lime by 12% for each inch more than 8. The rate of lime also needs to be adjusted for the actual effective neutralizing value (ENV) of the limestone being applied. The rate to be applied is calculated by dividing the recommended rate given (eg. in a soil test report or 1000 lb per 0.1 pH, corrected for plowing depth if \pm 8 inches) by the ENV of the lime to be used (check delivery slip for ENV of lime). If more than 4 tons per acre of lime is required, it may be applied in split applications by plowing half down and disking the remainder into the surface. The longer before seeding that lime can be applied, the better, but even spring applications can be beneficial. Using dolomitic limestone should be avoided, because it contains a high amount of Mg, which already occurs at very high levels in the Elba muck.

How to decrease soil pH

Soil pH may be lowered by adding sulfur. An application of 1000 lbs of sulfur per acre will lower the top 6 inches of soil about 0.4 pH units. Unfortunately, soils that contain marl or extensive amounts of free limestone (i.e calcium carbonate), as is the case in the Elba muck land, require large amounts of sulfur, making it cost prohibitive to treat these soils for an effect that would last only temporarily. In a Michigan study, 10 ton of sulfur was added to marly muck and it only reduced the pH by 0.2! Acid forming fertilizers such as mono ammonium phosphate (MAP), ammonium sulfate (14.4% sulfur; 694 lb = 100 lb of S) or manganese sulfate may be applied in a band at planting to improve the availability of P, Mn, Zn and B. In Michigan, 75-80% of muck onion growers are now banding starter fertilizer 2 to 3 inches below the seed, specifically to remediate the problem of high calcium and pH tying up nutrients.

In a nutshell:

- The Elba muck land has been identified as a major source of pollution into its local water shed, delivering excessive amounts of phosphorus and nitrogen.
- In response to these results, free soil nutrient tests were conducted for Elba muck growers in hopes that they would apply nutrients according to the needs of their soils. Together, the soil test results made an extensive database, the summary of which, is being presented in these three (Part I, II and III) newsletter articles.
- 13% of the soil sub-samples had less than 20% organic matter with the lowest reading being 2.4%. These soils although labeled on the county soil survey maps as muck, technically are no longer muck soil.
- There was a relationship between organic matter and pH; as organic matter decreases, pH increases.
- The majority (65%) of the fields/blocks had pH higher than the optimum (5.8) and 20% had pH between 6.7 and 7.3. The highest pH recorded in a single sub-sample was 7.6.
- Above pH 5.8 to 6.0, manganese, zinc (Zn), boron (B) and phosphorus are tied up and can become deficient.
- It is not possible to reduce soil pH by applications of sulfur on calcareous/marly muck soils like the Elba muck land. Instead, pH, Mn and P need to be managed by using acidifying fertilizers applied in a band and foliar sprays.

Word of caution about soil test results from different laboratories

Muck soil is unique compared to the more common mineral soils. There are many differences in the types of tests that different soil testing laboratories can use to measure the amounts of available nutrients to the crop. Not surprisingly, different tests can give different results. In New York, fertility recommendations were derived by Cornell researchers based on studies conducted on muck soil in New York and soil test methods used by Cornell. Therefore, the recommendations match the soil test procedures. This summer, there was an incidence where muck soil samples taken from the same field were sent to two different soil labs; one came back indicating available P was high and the other showed that it was low. This resulted from different analysis techniques; the accurate result was from the Cornell Nutrient Analysis Lab (CNAL), which is experienced in testing muck soils. As CNAL is transitioning to Dairy-One/Agro-One this year, extensive testing is underway to calibrate the different testing techniques of each lab so that Cornell recommendations may be accurately applied to test results from Agro-One.

2009 Elba muck land soil survey results available

If there are growers who would like copies of their soil test results, maps and recommendations, or for information on the database, contact Christy Hoepting (585-721-6953; cah59@cornell.edu). Look for “Part II: Phosphorous, Nitrogen and Potassium” and “Part III: Calcium, Magnesium and Micronutrients” in upcoming issues of *Veg Edge*.