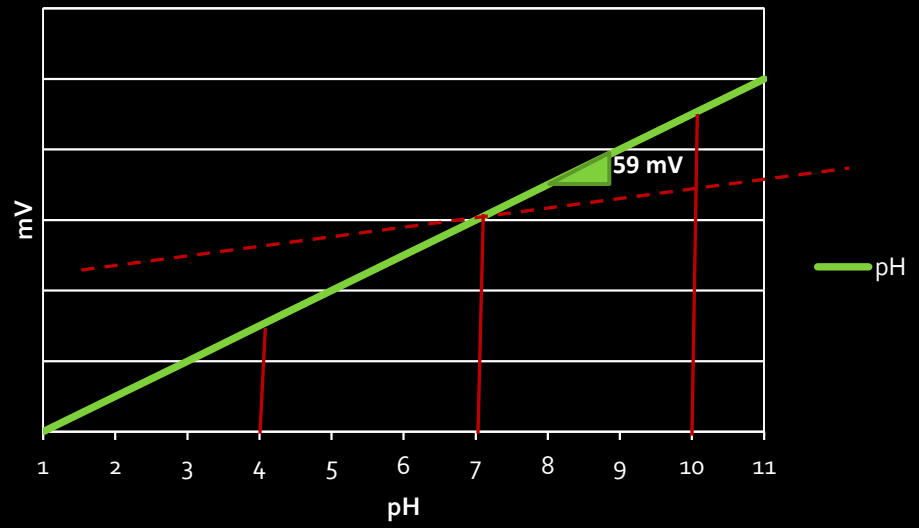
Ed Hanlon & Kelly Morgan

SOIL PH MANAGEMENT: SECOND GENERATION LINKS TO BMPS

pH and Soil Basics

- **Definition: pH = -log(Hydrogen ion conc.)**
  --*really activity*--
- **Scale: 0 to 14, acid to basic**
  - *Hanlon, E. A. 2011.* Soil pH and electrical conductivity: a county extension soil laboratory manual. *http://edis.ifas.ufl.edu/ss118*

Instrumentation:



- **Combined electrode/meter**
  - **Measures millivolts**
- **Calibration REQUIRES three standards**
  - *Usually, pH 4.0, 7.0, and 10.0*
    - Set the 7.0
    - Set the 4.0
    - Read the 10.0, If in error, recalibration

pH can be a Pain

- **Unless the meter completely fails, you will ALWAYS see a pH reading**
  - A 1 pH unit change is = to 59 millivolts
  - A human headache (neck pain) is caused by 7 to 20 millivolts
  - 1990-1991 survey of county labs: 16 of 19 labs were reporting readings, not soil pH

Soil pH: Who Cares?

- **Soil pH Controls A Considerable Number Of Reactions That Affect Plants And Microbes**
  - Ag Lime need and Recommended Rate

Liming

- **Lots of Misunderstanding about the use of Ag Lime**
- **We Lime a Soil to avoid Iron (Fe) and Aluminum (Al) toxicity**
- **Low pHs**
  - Fe and Al are active at low pH ranges (acidic)
  - The Mehlich-1 (M-1) and Mehlich-3 (M-3) extractants are both Acidic Extractants
    - M-3 is buffered (resists pH changes) at pH = 2.5
      - Fe and Al are brought into solution and can be measured

Liming (Continued)

- **We <u>Might</u> Lime to improve Nutrient Availability to Plants**
  - *This second reason is usually not all that important, but is often thought to be the Primary Reason*
  - *Proof:*
    - Toxicity problems for most plants are avoided between 5.0 and 5.5
    - Most optimum pH ranges are between 5.5 and 6.5

Liming (Continued)

- **If you have a soil with pH < 4.8, and you add mineral phosphate fertilizer, you are liming not fertilizing**
  - Phosphate ion acts similar to the carbonate ion
    - Phosphate is bound and unavailable to plants
  - Some of the bound phosphate may be released with time if the soil pH changes

Liming (Continued)

- **Soil pH alone does not say much about Liming Rate**
- **Active and Reserve pH**
  - Soil pH is the *Active* pH, that H in solution
  - The *Reserve* pH, that H on the solid phase, is NOT measured by measuring soil pH alone
  - UF uses the Adams/Evans Buffer and water pH with a Calibration Curve to recommend Liming Rate

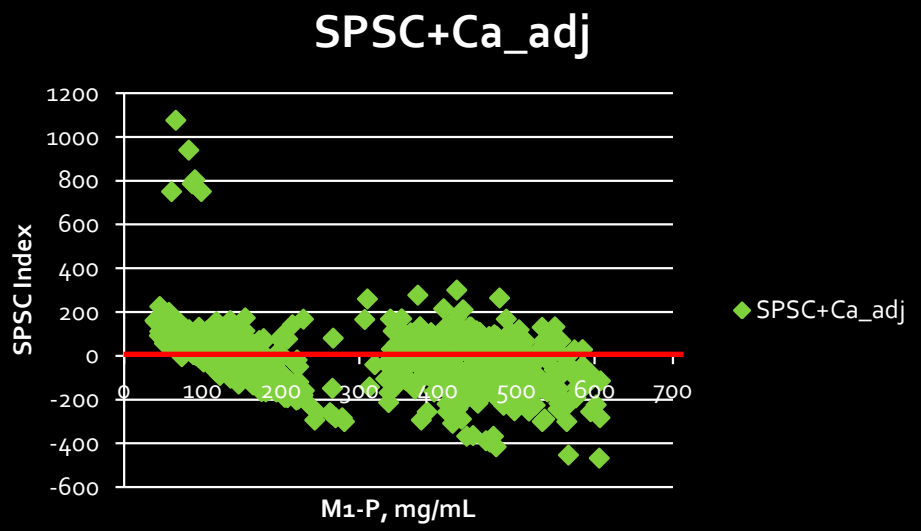
Future BMPs: Some New Uses for Soil Extractants, Based on pH

- **Fe and Al controls on nutrients**
  - Phosphorus Saturation Ratio: predicts when P concentration exceeds Fe and Al and/or Ca to hold P in the soil (saturation)
    - *Nair et al. 2010.* An Indicator for Risk of Phosphorus Loss from Sandy Soils; *http://edis.ifas.ufl.edu/ss539*
  - Soil Phosphorus Storage Capacity: Predictions with threshold points work for soil horizons and with several extractants including M1 and M3
    - *Nair et al. 2010.* Understanding Soil Phosphorus Storage Capacity. *http://edis.ifas.ufl.edu/ss541*

Vegetable Example: Soil Phosphorus Storage Capacity (SPSC)

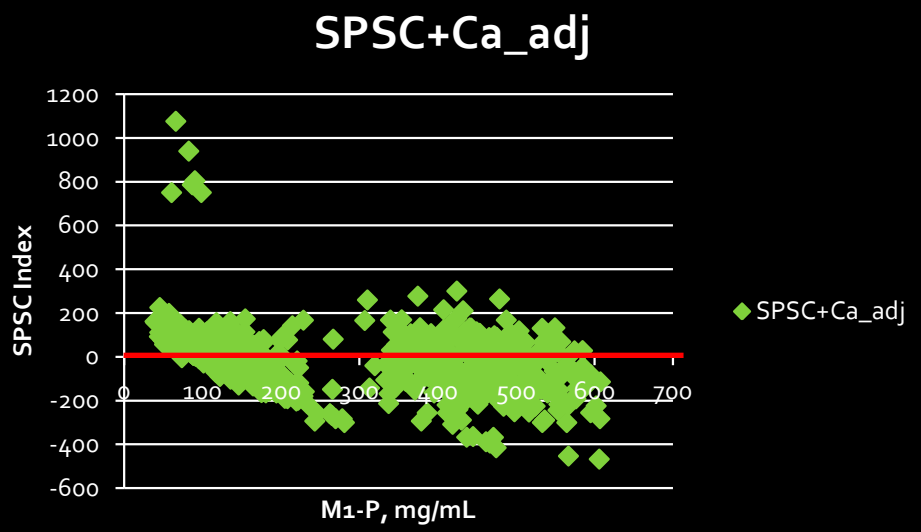
- >800 soil samples from 5 vegetable farms
  - Same Watershed, seep irrigation
  - Lime additions: ~1 ton ag lime/acre/yr (over-liming)
    - Lime was added for 15 years
  - Soil pH: 6.8 to 8.4 and extractable Ca
  - One farm used Organic Matter annually

SPSC: Continued



- When SPSC > 0 then P can be held in the soil
- When SPSC < 0 then P can be lost from the soil
- Crop response with proper soil pH is not expected when M1-extractable P is >30 ppm
- Most soils had excessive lime resulting in both high pH and high extractable Ca
  - P response is likely because of excess Ca reacting with P
- In this example, more than 50% of soils are predicted to lose P from the soil (SPSC is negative)

SPSC: Continued



- Preliminary interpretations indicate that:
  - The two data clouds are related to organic matter additions
    - Left side data cloud are mostly farms not adding organic matter (low % OM not contributing to P retention)
    - Right side data cloud are values mostly from the farm adding organic matter, or from farms with elevated %OM naturally (increased % OM also holding more P)
  - Due to high pH and extractable Ca concentrations, the SPSC included an adjustment for Ca

Conclusions

- **Soil pH:**
  - **Can be a reliable indicator for avoiding Al and Fe plant toxicity in mineral soils**
  - **Controls a number of important aspects of soil fertility and productivity**
  - **Is only one of the two soil tests needed for accurate liming recommendations**
  - **Reflects the Fe and Al and/or Ca, which in turn, can be used to control P movement**
- **The SPSC appears to have value when considering P movement and crop response**
- **Application of the SPSC in our example pointed to the need for improved soil pH management to benefit from P fertilizer additions**