C-139 Vegetable Production Demonstration Project

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Public Meeting on the Long-Term Plan for Achieving Water Quality Goals for the Everglades Protection Area Tributary Basins
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Agenda

- The C-139 Basin Vegetable Demonstration Project
- Plant Phosphorus Basics
- Soil Phosphorus and Soil Testing Basics
- The 2005-2008 Demonstration Project
- The Current Demonstration Project (2008 – 2011)
- Summary and Next Steps

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The C-139 Vegetable Demonstration Project

- Goals:
  - Evaluate the state standard Soil Test P index (Mehlich 1) for vegetable crops on the high pH soils with high P-Ca precipitates that are typical of the C-139 Basin,
  - Compare the four common soil extractants for development of a more reliable Soil Test P index for these soil conditions, and
  - Determine the effects on yield and plant characteristics of lowering soil pH to increase P availability thus reducing the need for new P application
  - Developed as a cooperative agreement between the SFWMD, FDACs, UF-IFAS and volunteer C-139 Basin growers

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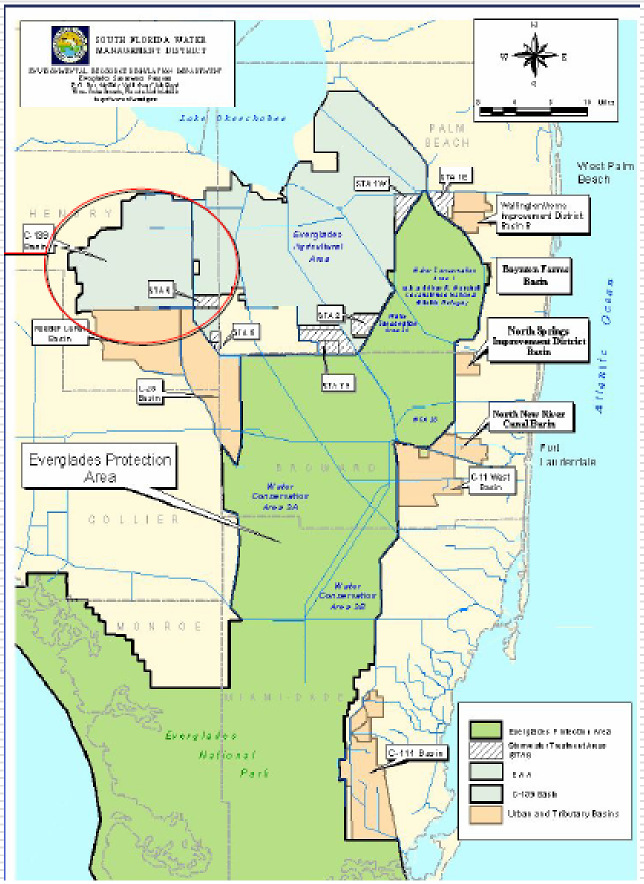
C-139 Basin Background



- Approximately 170,000 acres of agricultural production in Hendry County
- Commodities = vegetables, citrus sugarcane and pasture
- Vegetable production has increased over the past 10 years
- Since 2003, compliance TP monitoring has been conducted to determine no increases from 1978 - 1988 historic levels
- The basin exceeded TP load limits in 3 of the past 4 years.

Plant Phosphorus Basics

How much N, P, and K does a tomato field absorb (plants + fruit)?

Per 1000 cartons of tomatoes, about:

75 lbs N
20 lbs P_2O_5
140 lbs K_2O

How much N, P, and K leaves the field with the fruit?

Per 1000 cartons of tomatoes, about:

42 lbs N
10 lbs P_2O_5
90 lbs K_2O

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Soil Phosphorus

$H_2PO_4 \underset{}{\overset{Ca}{\rightleftharpoons}} CaHPO_4 \cdot 2H_2O \overset{Ca}{\rightleftharpoons} Ca_8H_2[PO_4]_6 \cdot 5H_2O \overset{F}{\rightleftharpoons} Ca_{10}F_2[PO_4]_6 \cdot 5H_2O$

Water Soluble	Bicarbonate extractable	Extractable with Acid
Plant Available	Partially available	Not plant available

- Sand holds very little P
- P precipitates out as Ca compounds in soils with pH>7.0 and Ca >600 ppm
- Available to plant for short period of time
- Soil test measures “extractable” P and not “total” P
- “Extractable” P may contain P not available to the plant

Soil Test P (Extractable vs. Available)

- A Soil Test measures extractable nutrients
  - ✓ Only a portion of extractable nutrients are available to the plant.
  - ✓ It is used as a basis to estimate plant-available nutrients and calculate fertilizer requirements (P index)

Soil test rating	Mehlich 1 Soil-test P (ppm)	Probability that crop will respond to P fertilizer
Very low	< 10	Very good
Low	10 – 15	Good
Medium	16 – 30	It might, it might not
High	31 – 60	About zero
Very high	> 60	No chance

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P Availability in C-139 Basin Soils

- P most available to plants in the pH range of 5.5 to 6.5, even with high Ca concentrations
- P is increasingly not available above pH 7.0 in high Ca soils
- C-139 Basin soil pH ranges between 7.0 and 8.1, and soils have high Ca concentrations
- The State standard Soil Test P (Mehlich 1) provides best results on soils below pH 7.2
- Use of an index based on the Mehlich 1 method may not provide most accurate results for C-139 Basin conditions.

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The 2005-2008 Demonstration Project

- Five sites
- Duration = three years
- Crops = tomato, peppers, and green beans
- Soils pH = 7.0 to 8.1

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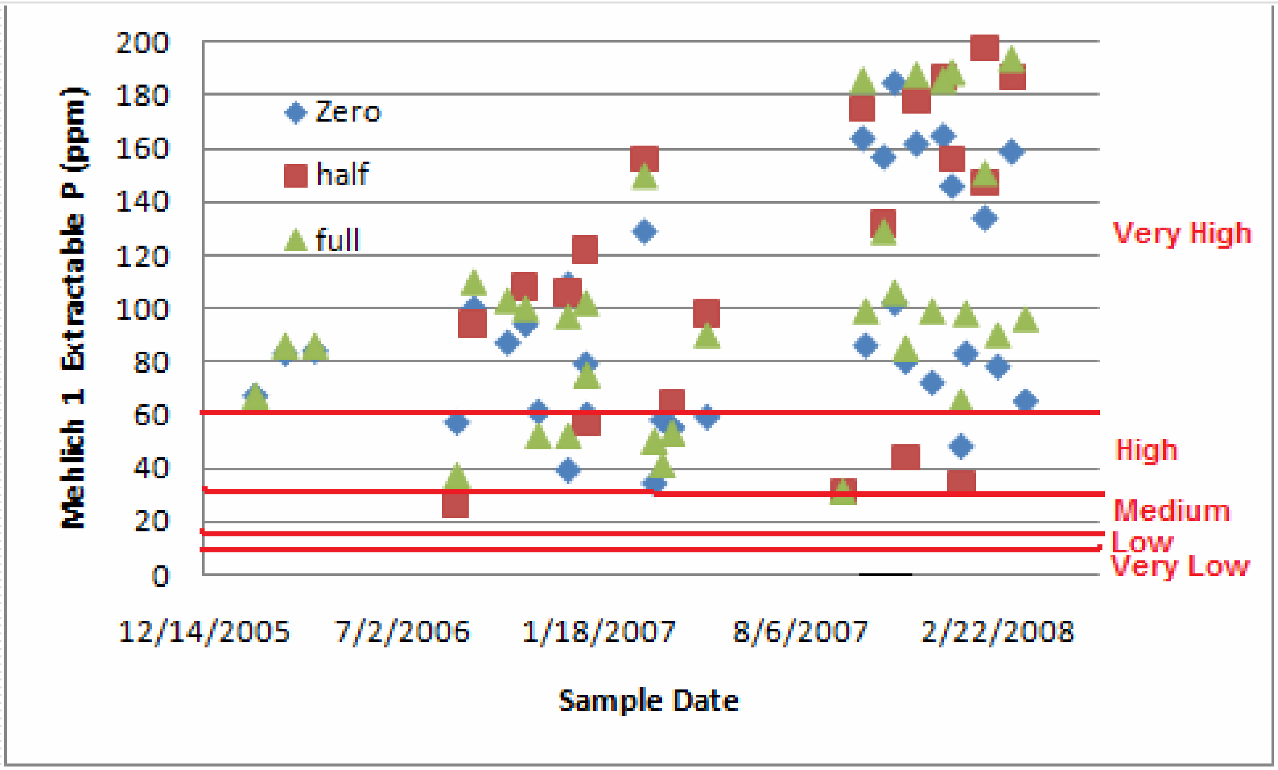
Crop and Soil Test Summary

Farms	Spring 2006	Fall 2006	Spring 2007	Fall 2007	Spring 2008
1	Tomato	Tomato		Tomato	Tomato
2	Eggplant	Green beans	Peppers	Green beans	Corn
3a	Tomato	Green beans	Tomato	Green beans	Green beans
3b	Green beans	Green beans	Green beans	Green beans	Green beans
4			Tomato		

- All soil P values in the high to very high P index
- Soil Ca very high (>400) in all plots
- Greater growth and yield was associated with sites on the lower end of the pH range suggesting the importance of pH adjustment to reduce P needs

Change in Soil Test P over Time



- Soil P stays high even for Zero P plots
- Indicates that non-plant-available P exists in the soil to be “extracted”
- Extended evaluation is needed to determine how long it will take to for the Soil P to decrease.

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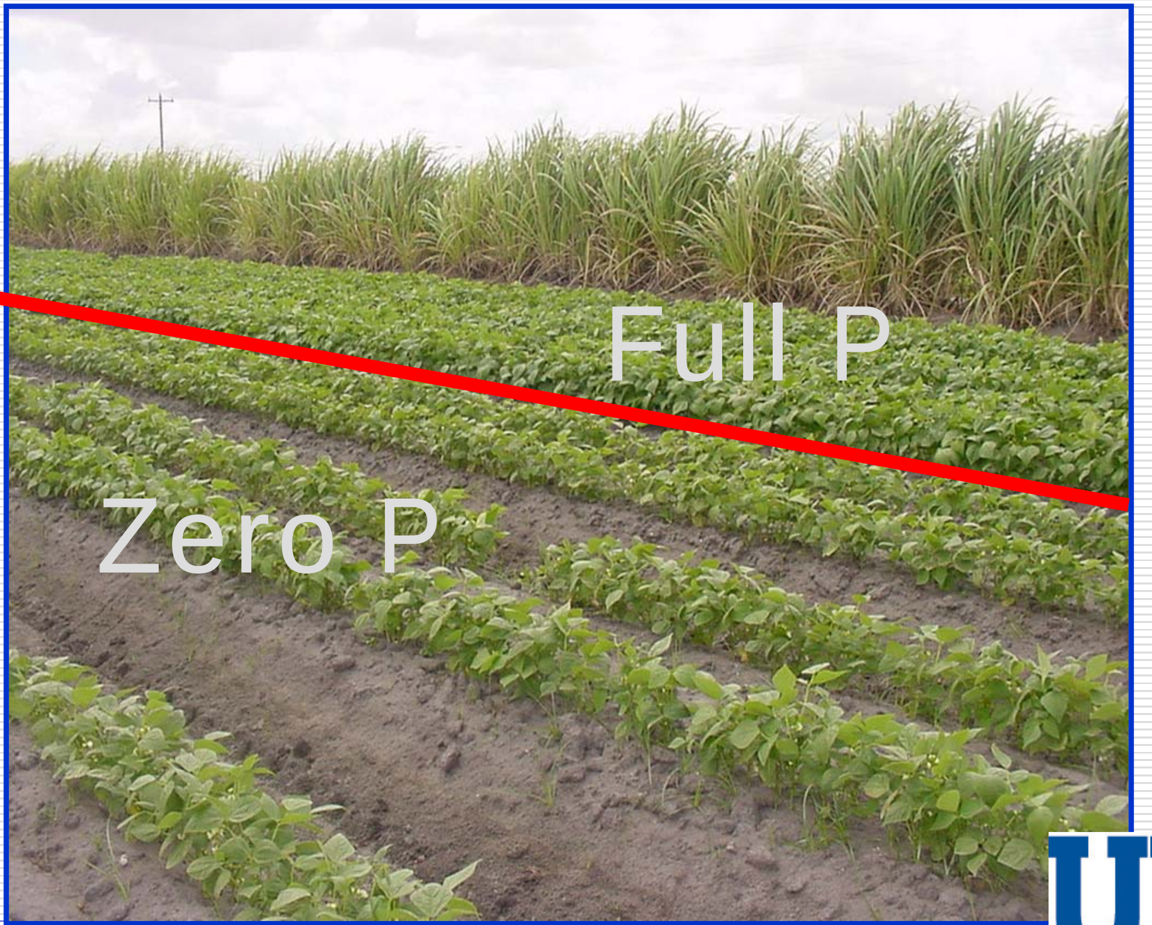
Effect of P Application on Growth and Yield



- Green Beans
  - Significant reduction in plant growth and yield with reduced P
  - Some evidence of reduced leaf P conc. with reduced fertilizer P
- Tomatoes
  - Some significant increase in number of large fruit
  - No statistically significant effect on total yield

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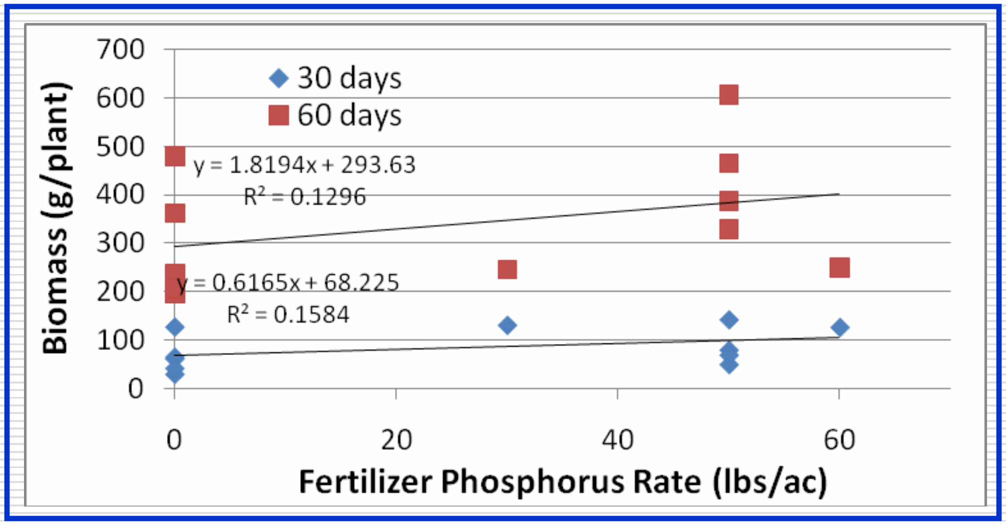
Green Bean – Growth Response



- Leaf P was in the optimum range at all sample dates
- Leaf P significantly greater in the full P rate 28% of samples compared with zero rate
- 44% of sample had significantly greater biomass at 30 and 60 days after planting with increased fertilizer P

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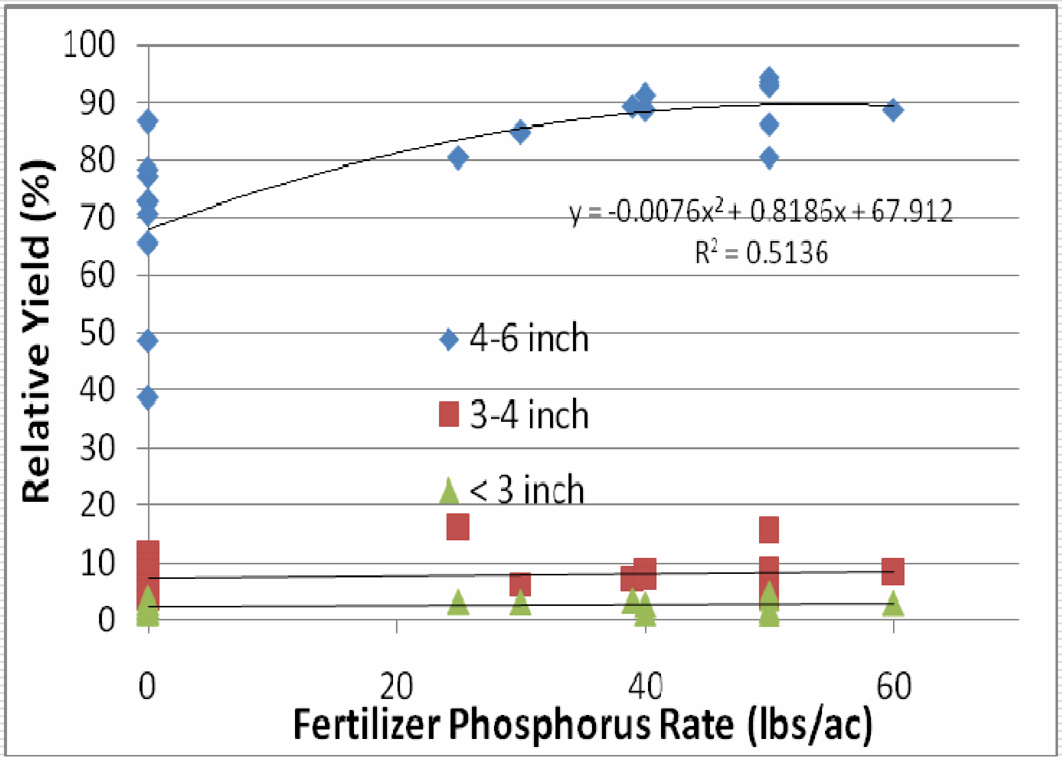
Green Bean – Yield Results



- Some indication (28% of crops) of significant yield increase in pods < 3 inches long with increased P added
- Increase in yield of pods > 4 inches long with increased P rate were significant (78% of crops)

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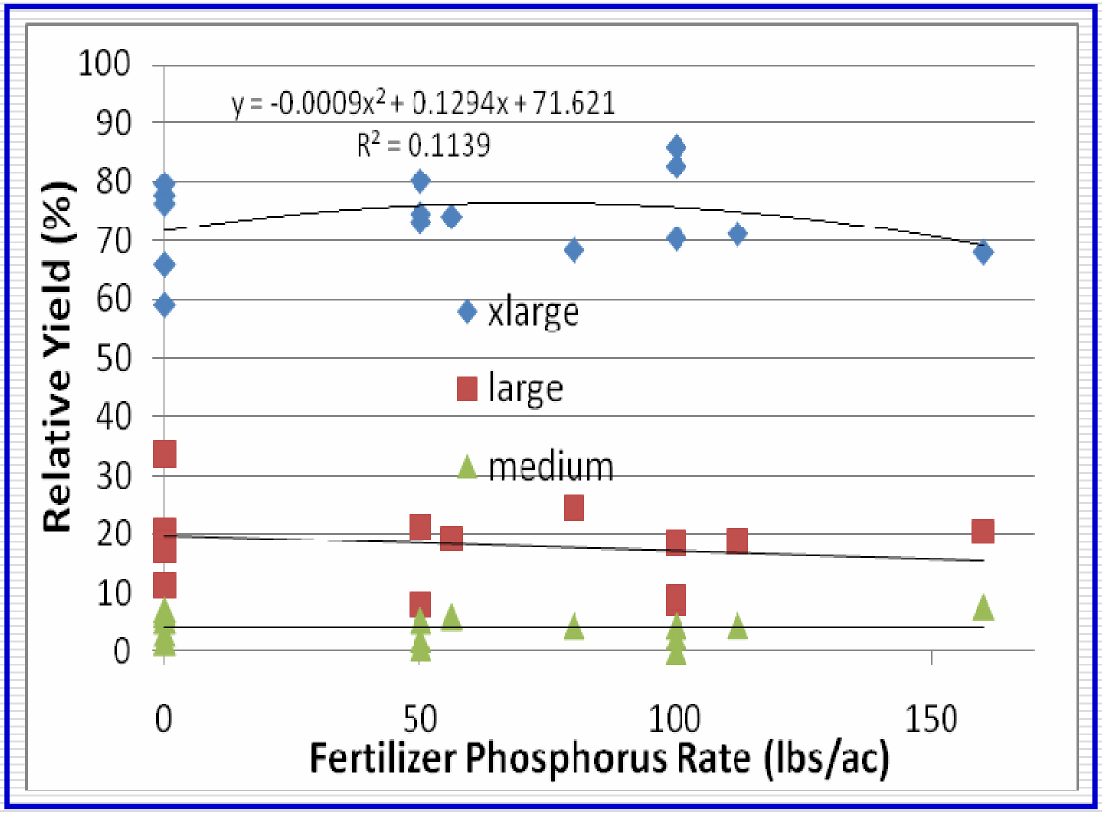
Tomatoes – Yield Results



- Some significant difference in yields by fruit size
- Earlier Large and Xlarge fruit (first harvest) <20% of time
- Higher yield of large (6x6) fruit at full and half P rates

The Current Demonstration Project (2008 – 2011)

- Continuation of first 3 year study
  - 4 Farms per season
  - 3 Fixed fertilizer P rates (one additional rate)
- 4 soil extractants compared with Mehlich 1
  - Develop appropriate soil test P index for C-139
  - Mehlich 3 (future State standard), Olsen, Brey and AB-DTPA
- Sequential analysis conducted to determine the soil P forms
  - Determine plant available P
  - Establish P form extracted by the different extractants
  - Identify the extractant that best measures plant available P in C-139 soils

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The Current Demonstration Project (2008 – 2011) - continues

- Enhanced soil P availability with pH adjustment
  - An evaluation of amendments to reduce pH was conducted. Only S was identified as a practical at that time.
  - One site in the Fall (2008) and one in the Spring (2009)
  - Uses the minimum S rate to affect desired pH change
  - Rates are based on current UF-IFAS Soil Test recommendations
  - All S was banded at the root zone along with P as a potential BMP
  - Reduced application rate 250 lbs/acre in comparison to industry practices (approx. 1000 lbs/acre.)
  - Water quality samples are collected for S and P to determine the differences for the ditches serving the different sample plots.
  - Continue research on alternate amendments for pH adjustment and dissemination to growers.

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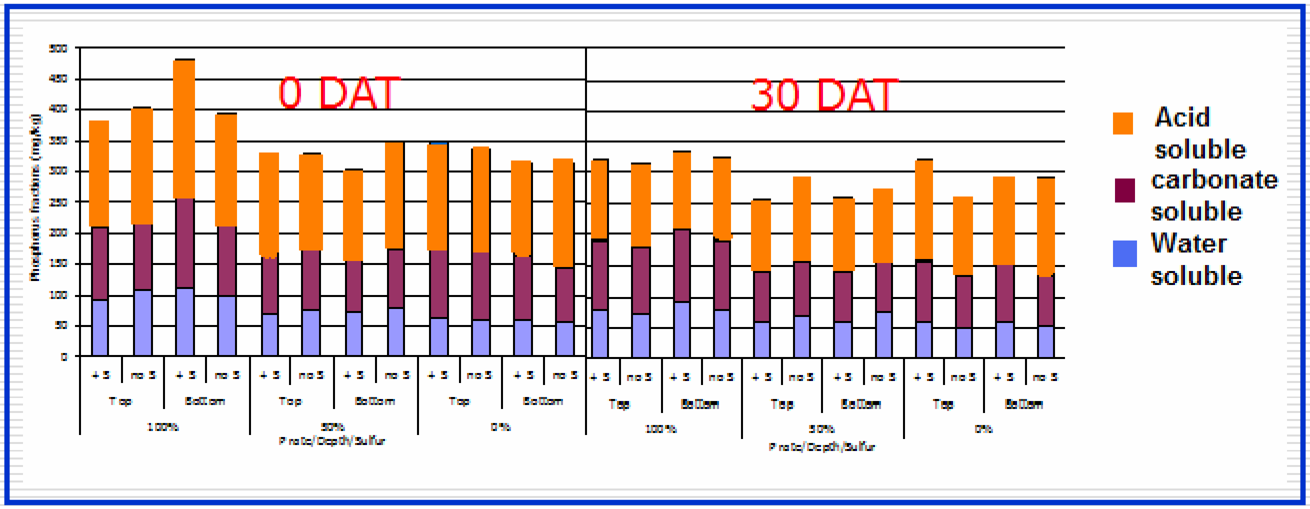
Sequential Soil P Analysis



- Approximately 25 and 50 mg/kg applied at the 100 and 50% P rates
- Nearly all added P in water soluble fraction at planting (0 DAT, days after transplanting)
- Reduction in water soluble P and increase in Carbonate extractable P at 30 DAT
- Reduced available P form (crop uptake) and increase in first precipitation form
- Little change in other soil (non-available) P fractions

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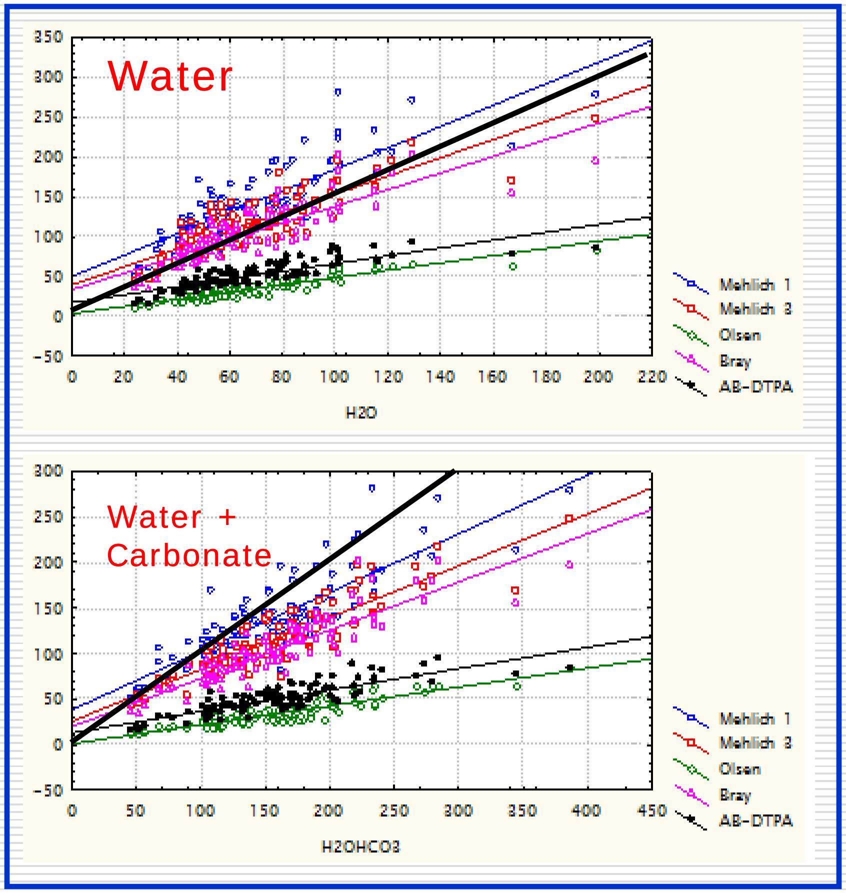
Comparing Extractable P with P Fractional Analysis Results



- Mehlich 1 extracts more P than in the water soluble fraction and nearly all the P in the water and carbonate fractions (may over-estimate available P)
- Mehlich 3 and Brey extracts nearly all of the water soluble fraction and little of the carbonate fraction
- Olsen and AB-DTPA extracts only the water soluble P fraction (may under-estimate available P)

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S Application and Field Ditch Water Samples (Preliminary Results)

- Elemental S is used to reduce soil pH
- Recommended pH range is 5.5 to 6.5 for improved nutrient availability
- Current S rates can approach 1000 lbs/ac
- Typical applications are above 200 lbs/ac
- Mean S in ditch water entering test field (outside source) = 0.023 ppm
- Mean S in water from ditches adjacent to S applied plots increased on average by less than 0.001 ppm compared with plots receiving no added sulfur

Continued Review of Alternatives for pH Adjustment

- Sulfur coated fertilizer
  - **Positives**
    - Further reduction in elemental S added to the soil,
    - Reduction in number of steps involved in application,
    - S is bound to the fertilizer particle so S runoff is less likely, and
  - **Negatives**
    - Moderation of soil pH is only in the immediate vicinity of the fertilizer pellet and not effective outside that zone, and
    - Higher cost per unit fertilizer amount

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Continued Review of Alternatives for pH Adjustment

- Chemically stabilized P (ionic retention)
  - **Positives**
    - No soil added elemental S, and
    - Additive fixes P so Ca does not
  - **Negatives**
    - New on market with few field results available,
    - No protection of P away from fertilizer particle, and
    - Higher costs

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Summary and Next Steps

- Crop responses to P application indicate that industry applied P levels can be optimized,
- However, project continuation is needed for development of a reliable index.
- Water quality monitoring for the different plots is starting to provide insight on how it relates to the different P and S application levels
- Continued investigation on alternate amendments for modifying soil pH is needed.
- Long-term tracking of soil P is needed to determine legacy P issues on “no P applied” plots.

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