Effect of soil pH and soil application of Calcium, Magnesium and micronutrients on citrus health

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Soil pH

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Alkalinity

Primarily determined by presence of bicarbonates (HCO_3^-), Carbonates (CO_3^-), and hydroxides (OH^-) in water.

A measure of the capacity of water to neutralize acids.

Alkaline compounds in water remove H^+ ions and lower the acidity of water (increase pH).

Limits nutrient availability in soils

Bicarbonates in Water

Water above pH 7.5 is usually associated with high bicarbonates.

Recommend levels of 100 ppm or less

Forms bicarbonate salts with Ca, Mg, Na, and K.

High Ca concentrations will react to form Calcium carbonate or line.

Higher calcium carbonate in soils increases pH making many nutrients less available.

Particulates can drop out of water and plug emitters or microsprinklers.

Soils with excess Ca forms $CaCO_3$ (lime).

Treatments:

- calcium or gypsum (calcium sulfate) to increase calcium availability to plants and soil,
- elemental sulfur can be used to reduce soil pH,
- applications of acidified water or acidic fertilizer

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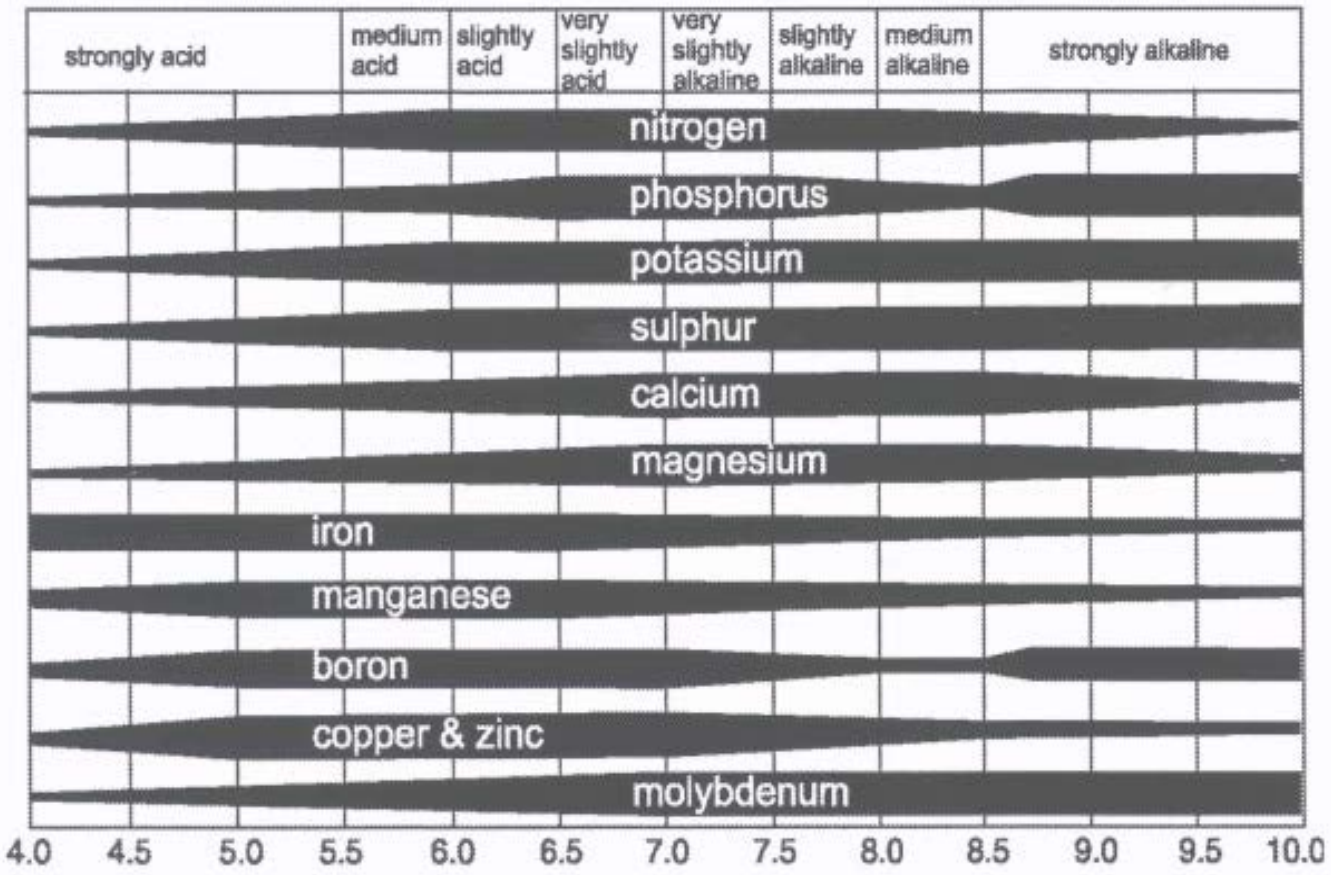
Effect of Soil pH on Nutrient Availability



Macronutrients (N, K, S, Ca and Mg) highly available between soil pH 6.5 and 8

Micronutrients (Mn, Zn B, and Fe) most available below soil pH 6.5

Best soil pH range for most crops is 6 to 6.5

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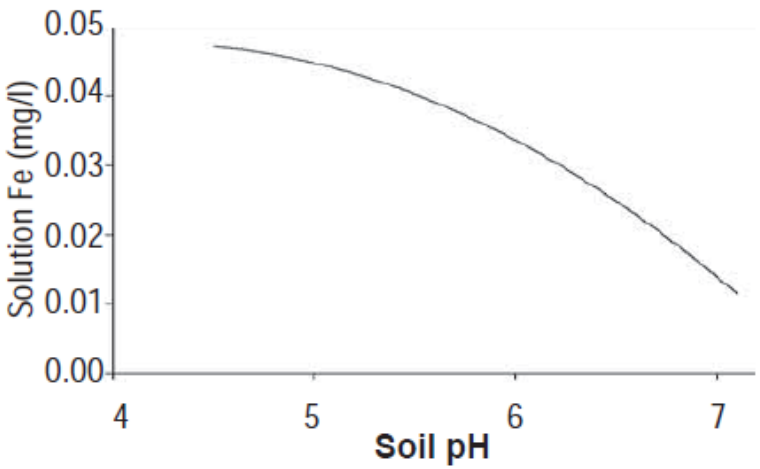
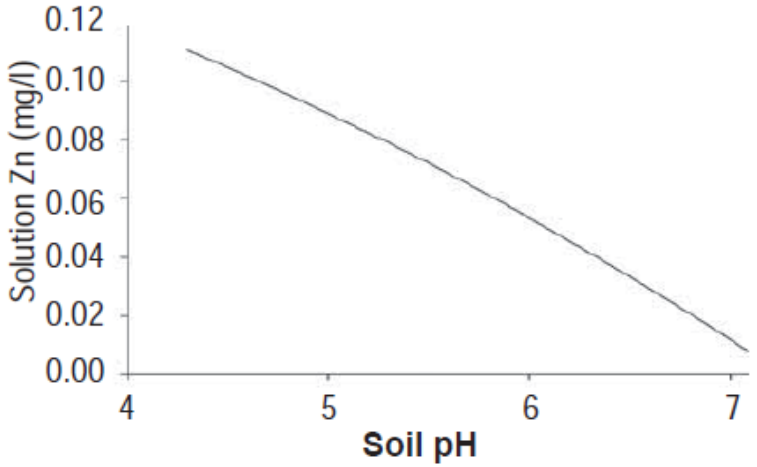
Plant Uptake

- ✓ **Bicarbonate induced chlorosis is caused by transport of bicarbonate into the plant leading to reduced nutrient uptake.**
- ✓ **Lime-induced chlorosis effects many annual crops and perennial plants growing on calcareous soils.**





Horneck, D. 2006. Acidifying Soil for Crop Production East of the Cascades. Oregon State

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Grove Soil pH Survey

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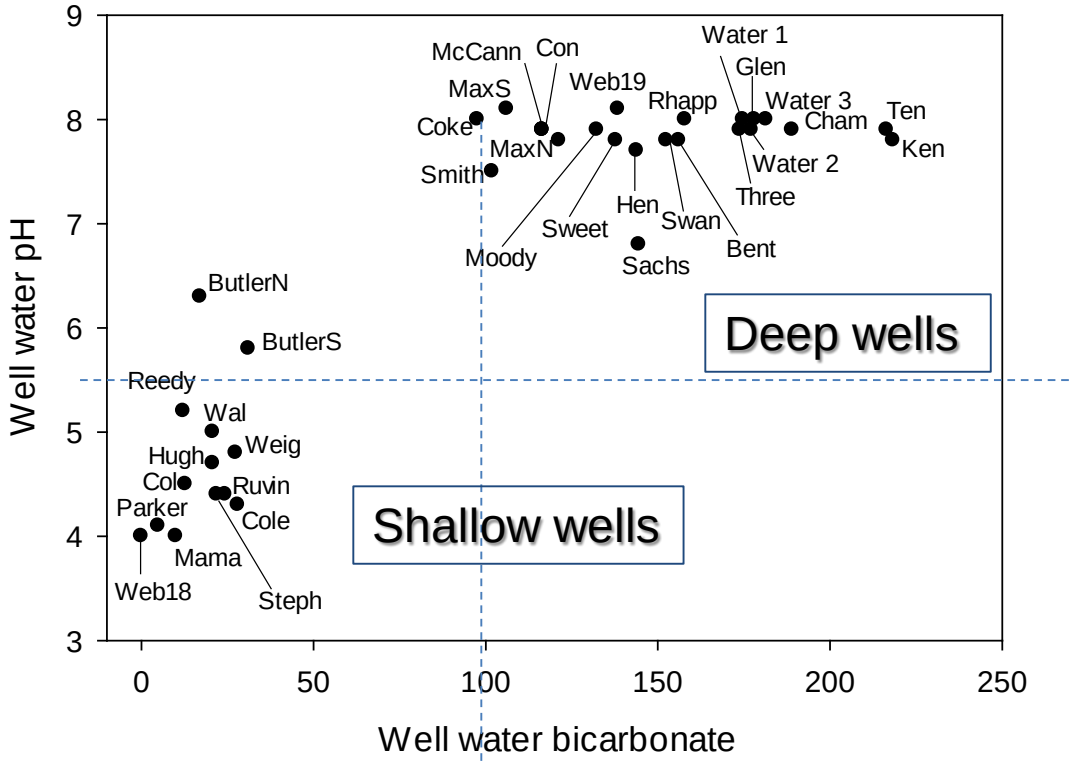
Survey of groves on Swingle and Carrizo

Data from Davis Citrus Management



Well water pH and bicarbonate levels are related in Central Florida citrus groves

J.H. Graham, 2014- 2016 survey of central Florida citrus groves for effect of bicarbonates

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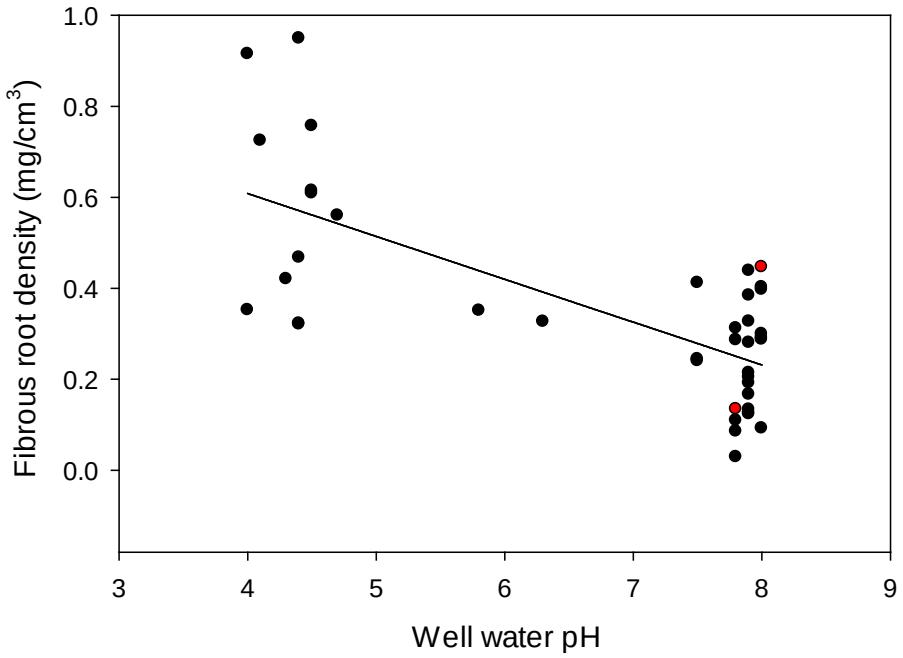
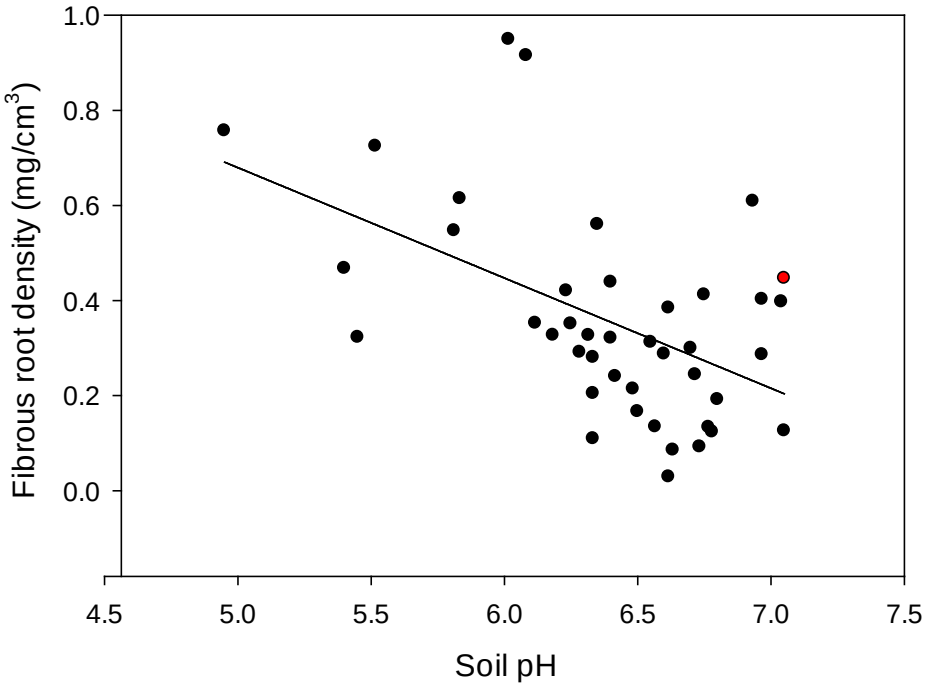
Lower Root Density is related to higher pH

Well water pH



Soil pH in the wetted zone



J.H. Graham, 2014 - 2016 survey of central Florida citrus groves for effect of bicarbonates

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Field Study: Effect of Soil pH on Nutrient Uptake

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Effect of soil pH on Nutrient status

- Mature Hamlin/Swingle – initial soil pH 7.3
- Irrigation water acidified for 3 years
- Soil pH range from 4 to 7.3
- Methods of pH moderation
  - Irrigation water acidification
  - Application of slow release sulfur product
- Soil and tissue samples, and yield estimation

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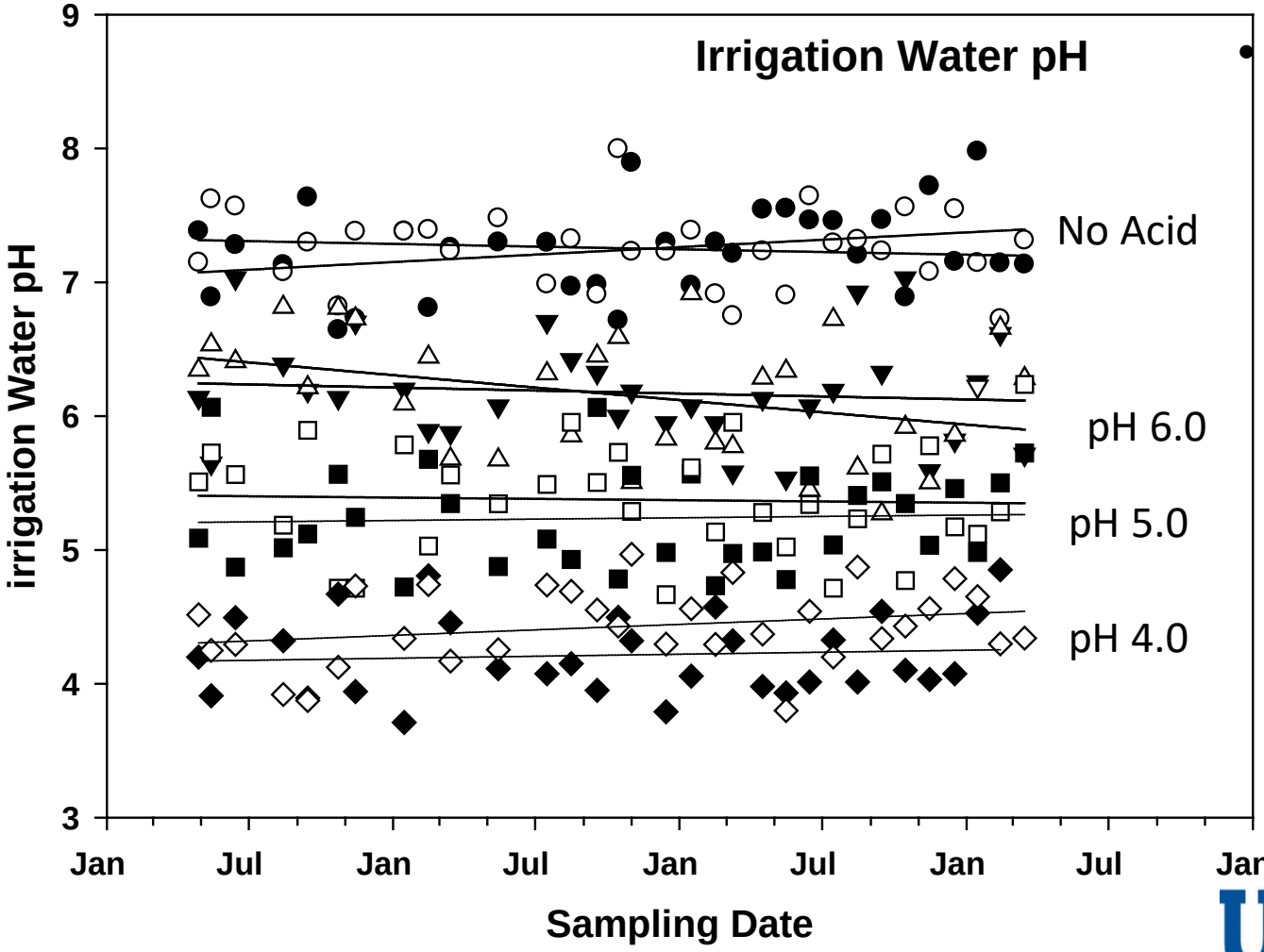
Effect of Acidificaiton on Water pH



Irrigation water within half a pH unit of target

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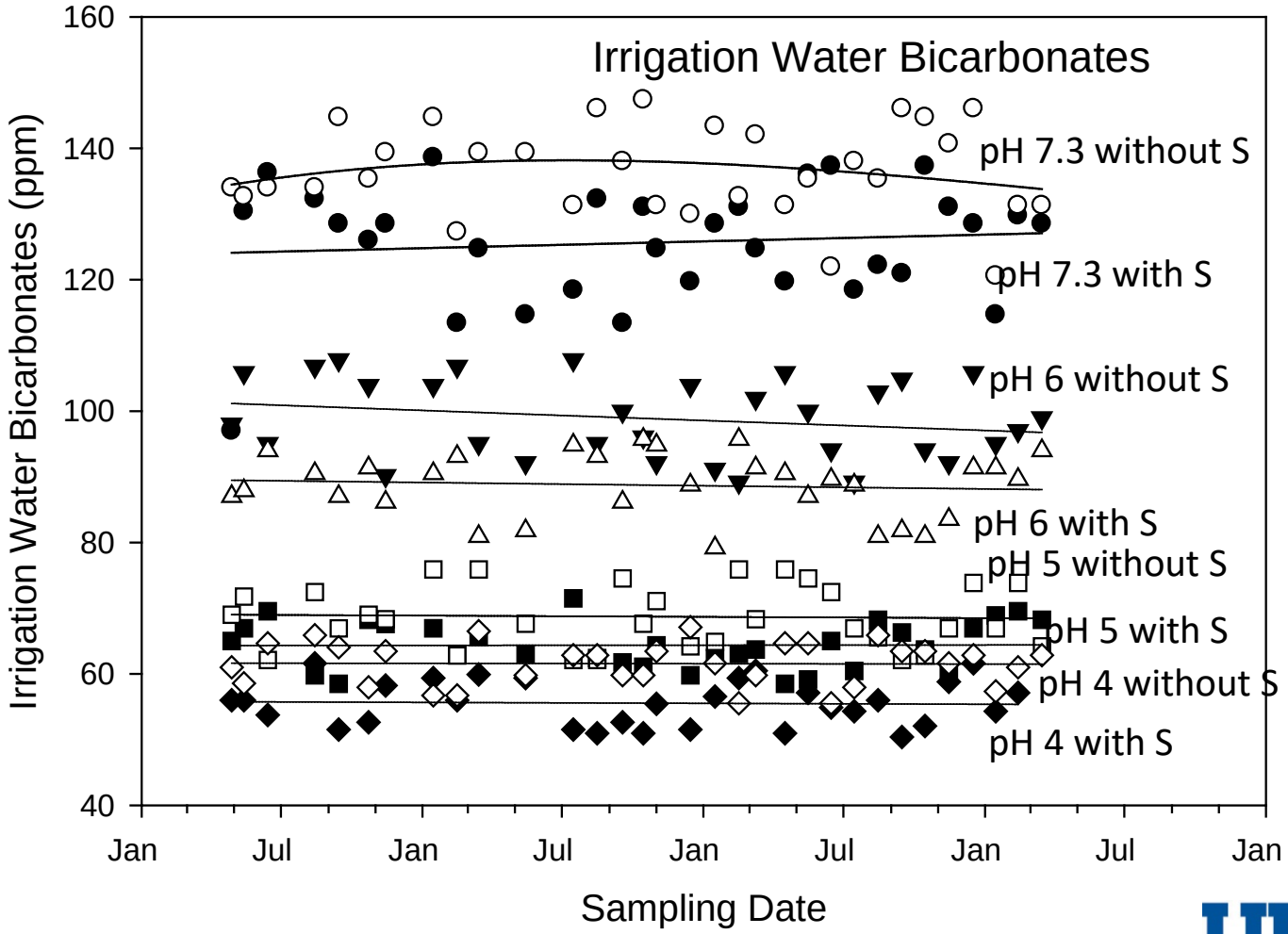
Effect of pH on water Bicarbonates



Suggested bicarbonate limit = 100 ppm

Little reduction in bicarbonates below pH 5

Soil applied S has no effect of irrigation water pH

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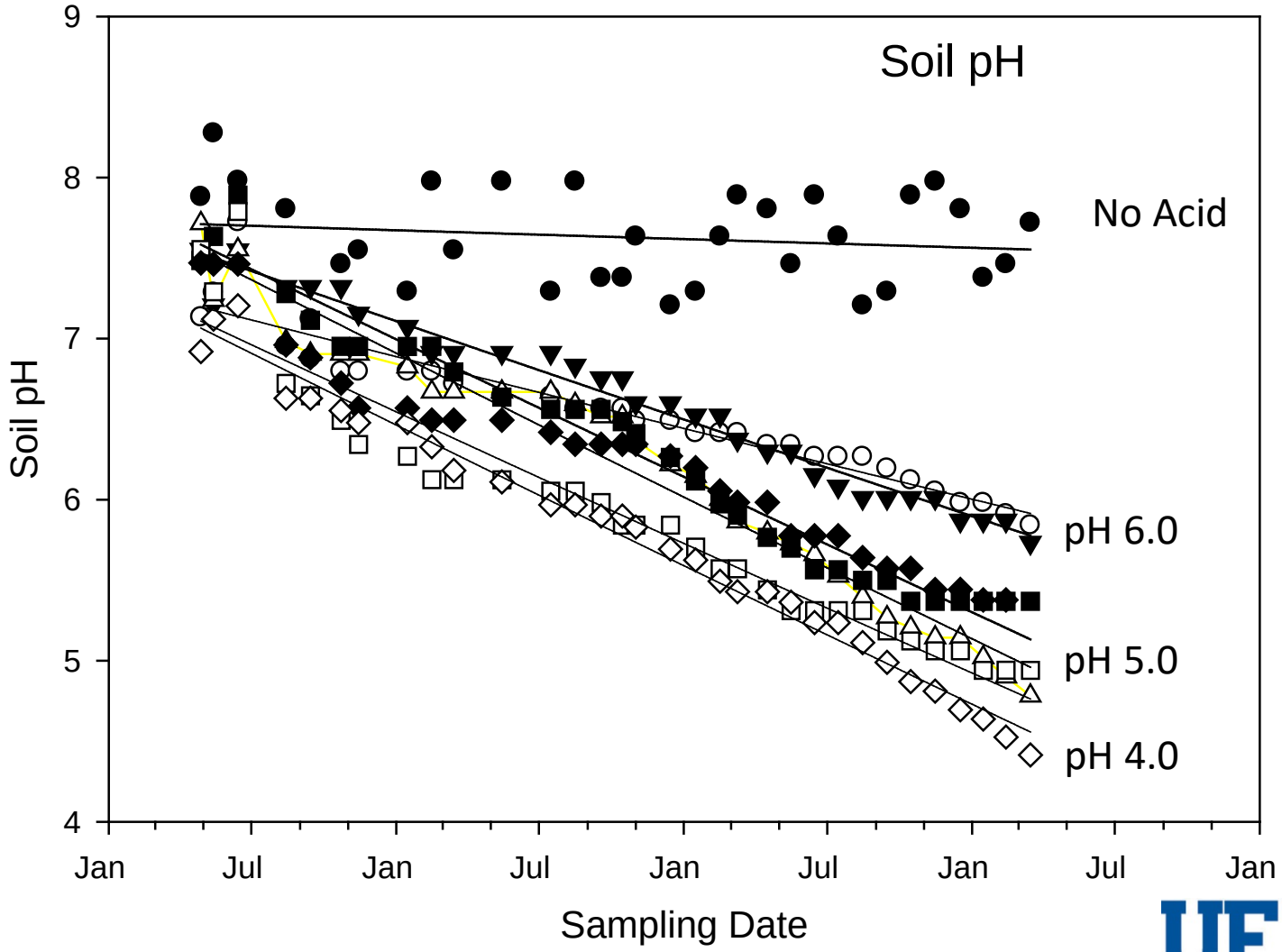
Effect of Irrigation Water pH on Soil pH



Three years to reach target pH

Applied soil S lowered pH by less than half pH unit

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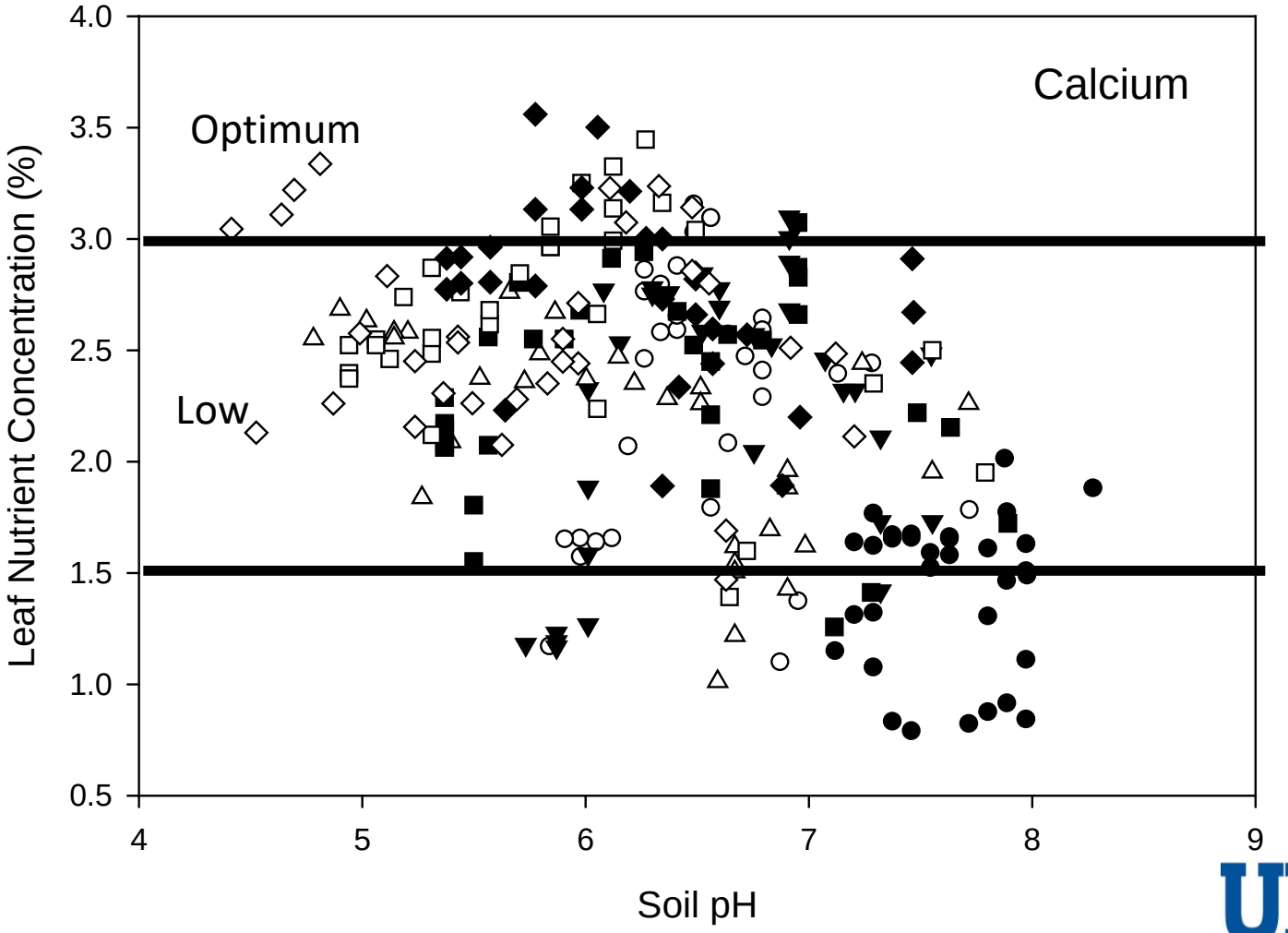
Effect of Soil pH on Leaf Calcium



Leaf calcium increased with lower soil pH

Calcium increased above optimum level below pH 6.5

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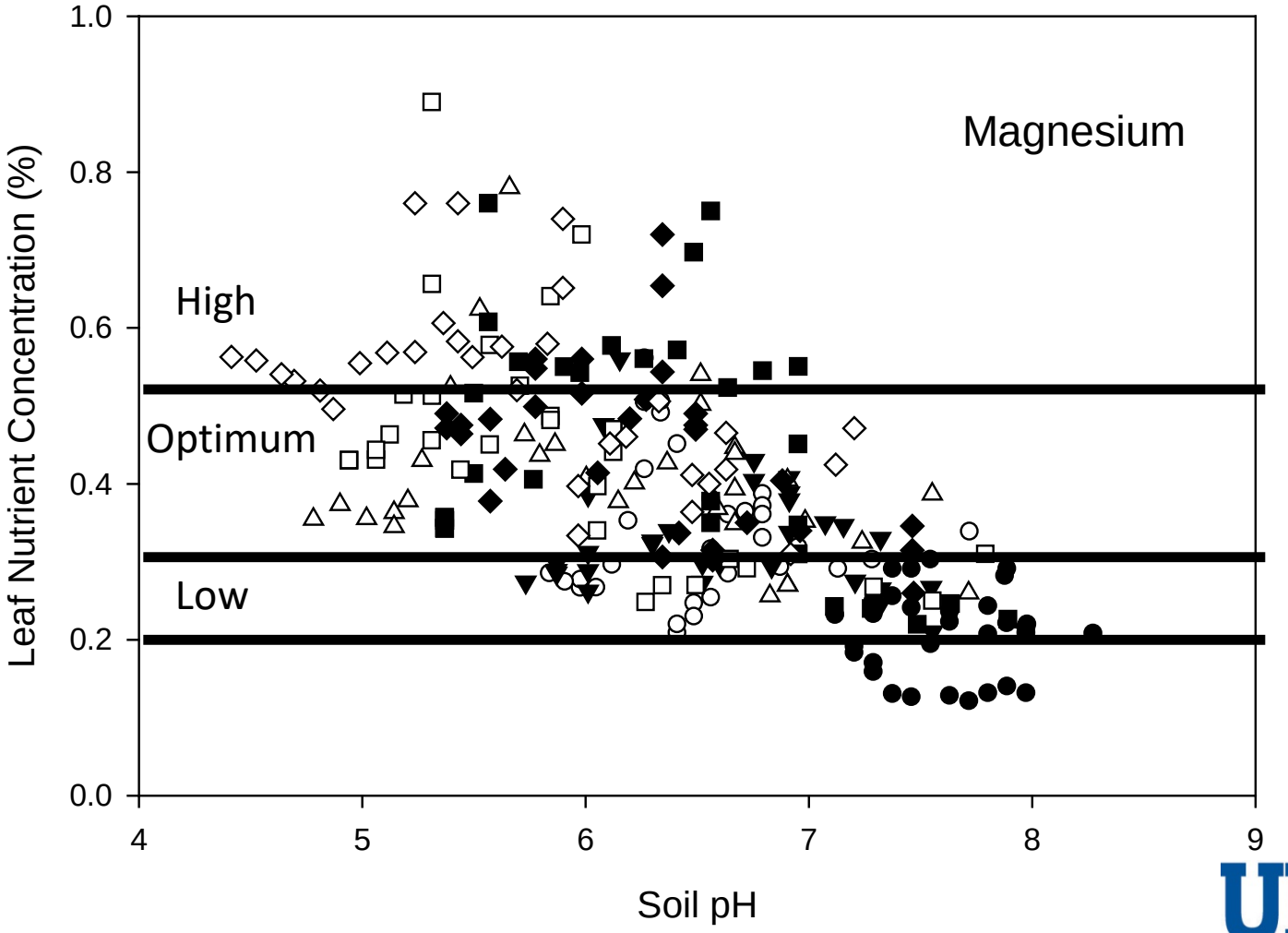
Effect of Soil pH on Leaf Magnesium



Increased leaf Mg with lower soil pH

Leaf Mg concentrations above optimum below pH = 6.5

Leaf Mg in high optimum or higher below soil pH = 6

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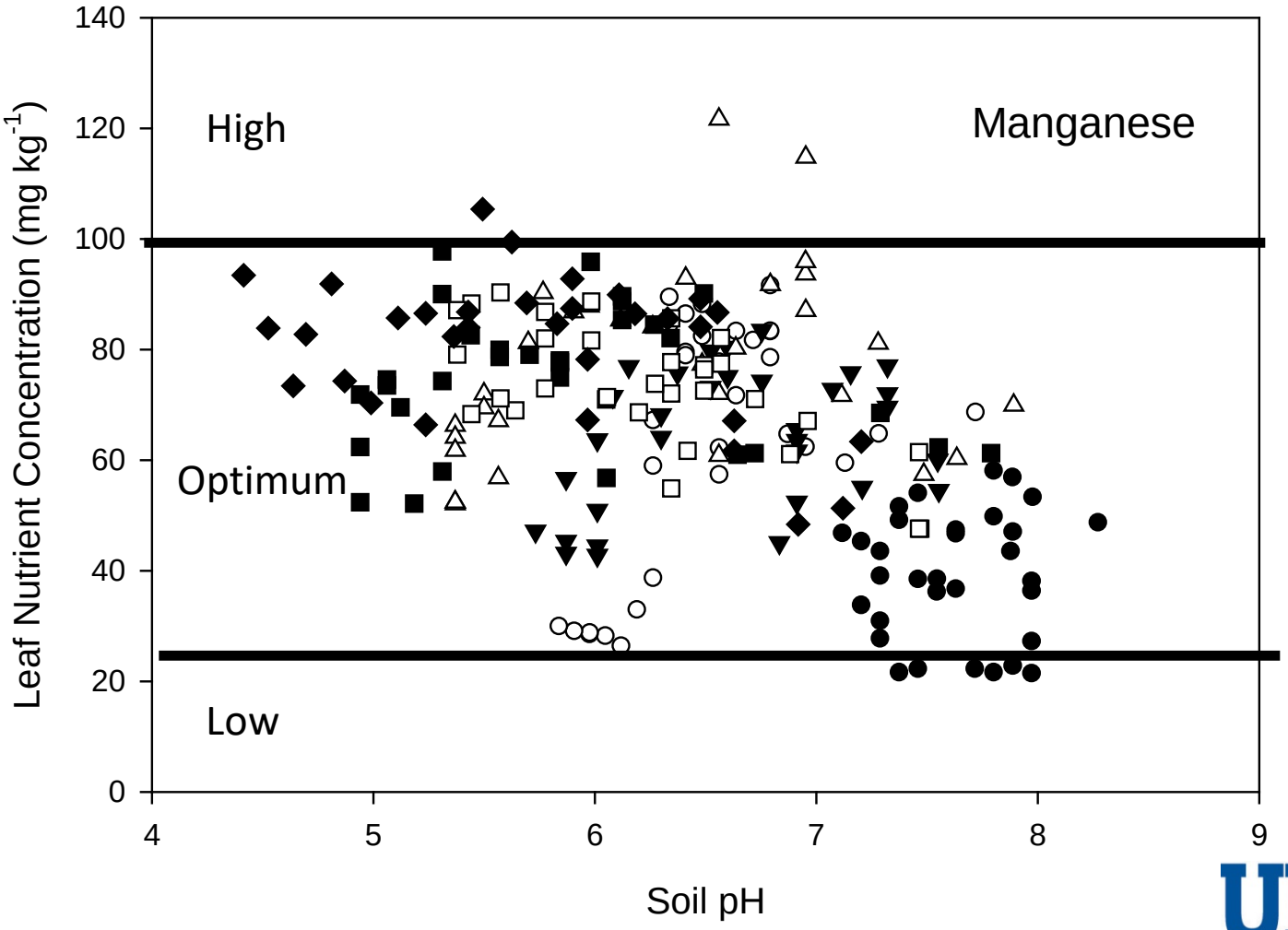
Effect of Soil pH on Leaf Manganese



Increased leaf Mn with lower soil pH

Leaf Mn concentrations above optimum below pH = 7

Leaf Mg in high optimum or higher below soil pH = 6

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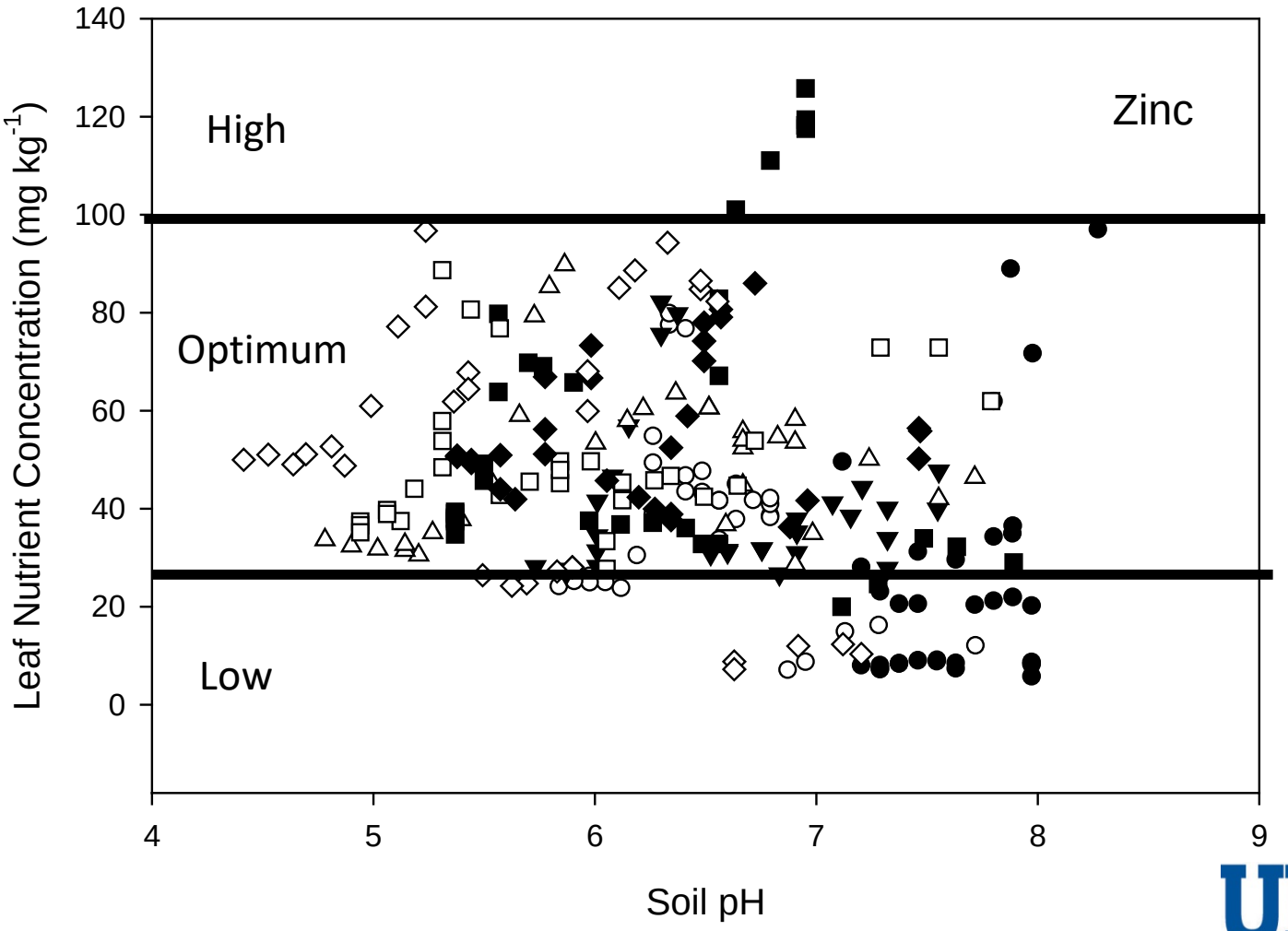
Effect of Soil pH on Leaf Zinc



Increased leaf Zn with lower soil pH

Leaf Zn concentrations above optimum below pH = 7

Leaf Mg in high optimum or higher below soil pH = 5.5

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Soil Calcium and Magnesium Applications

- Study started in Jan. 2017, set as zero day of the three years study.
- 10 year old Hamlin on Cleo and Hamlin on Swingle
- Treatments (T): control (T1), full Ca dose (T2), full Mg dose (T3), and half Ca and half Mg doses (T4), (full dose=45 kg ha^{-1}).

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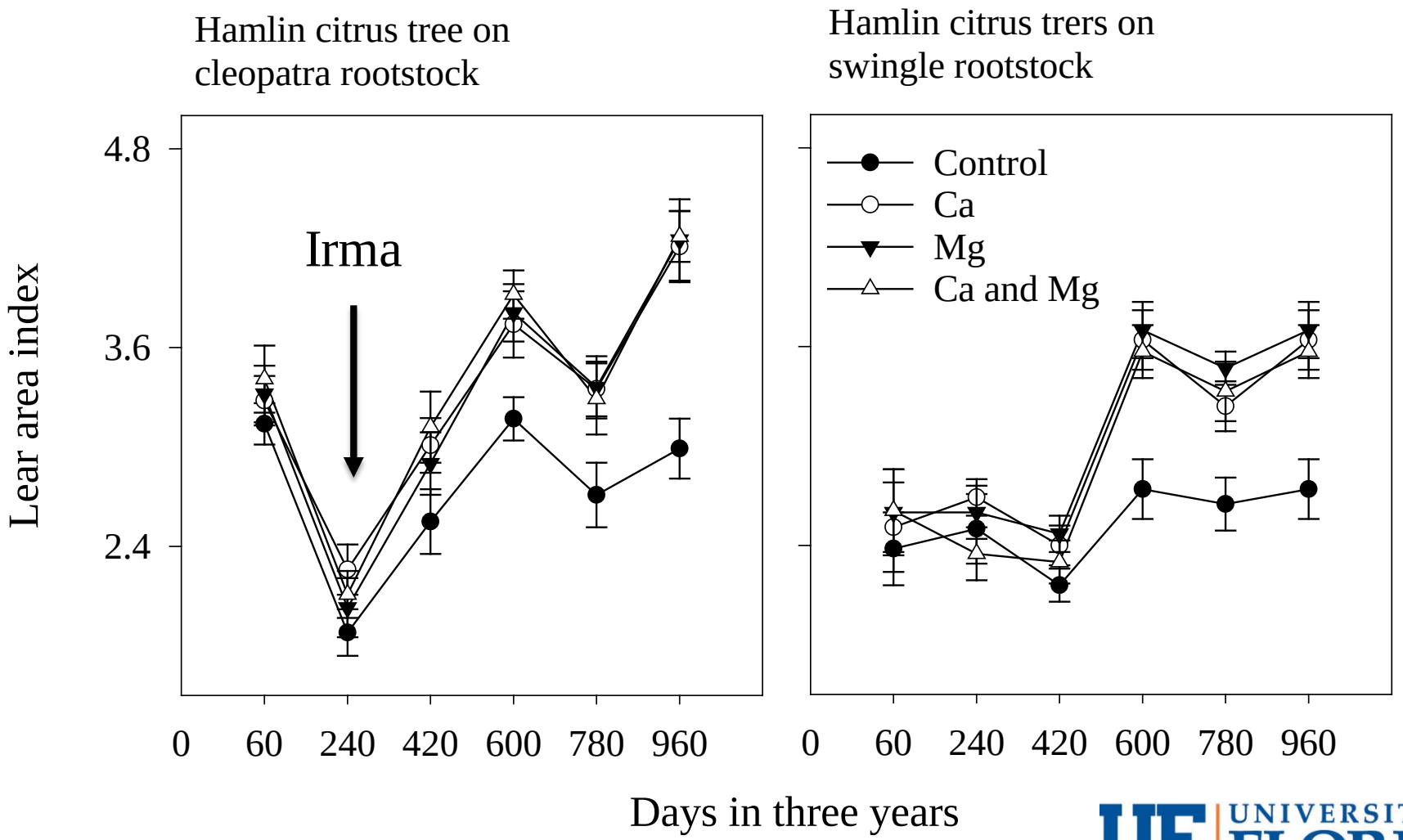
Effect of Calcium and Magnesium on Leaf Area



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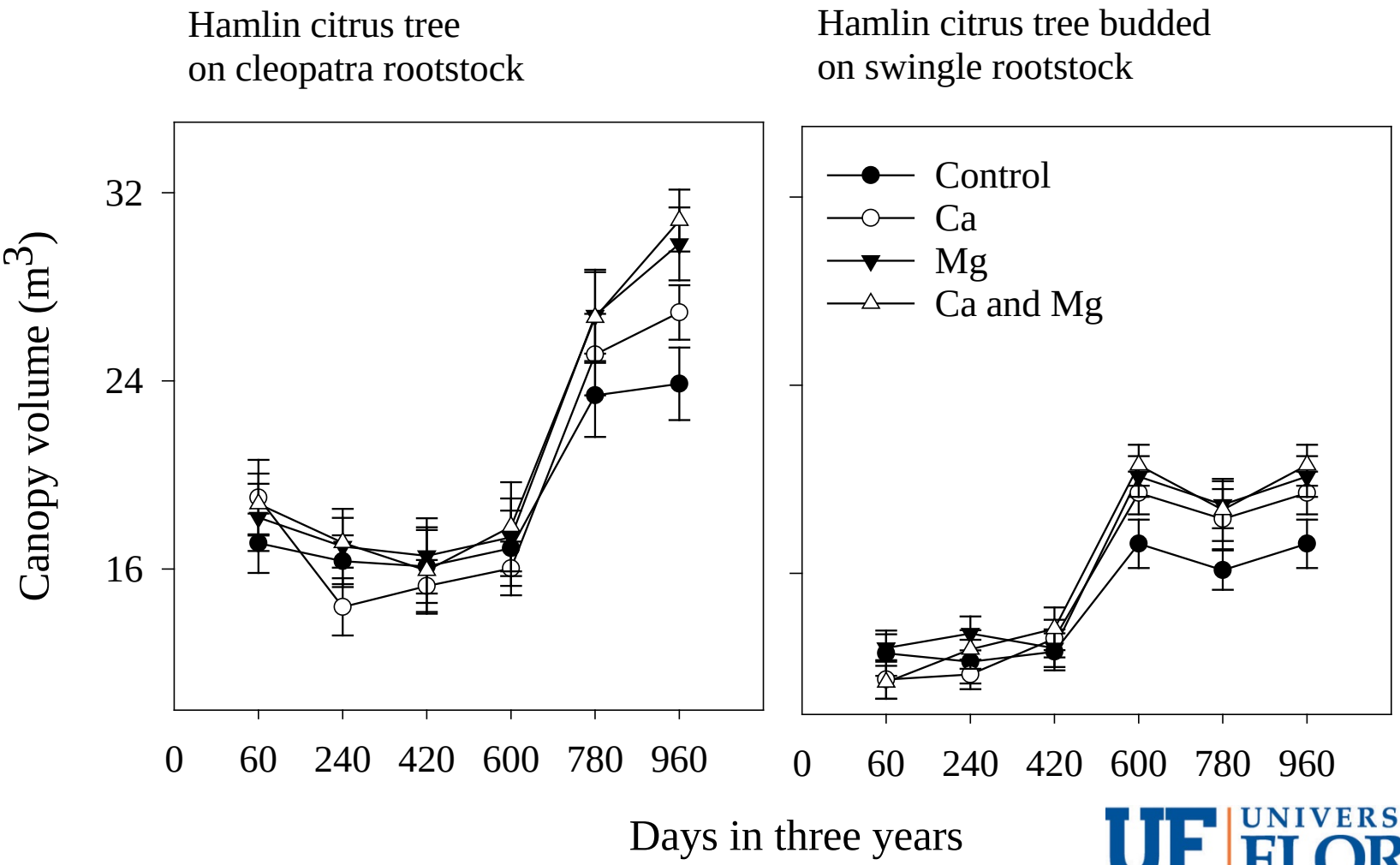
Effect of Calcium and Magnesium on Canopy Volume



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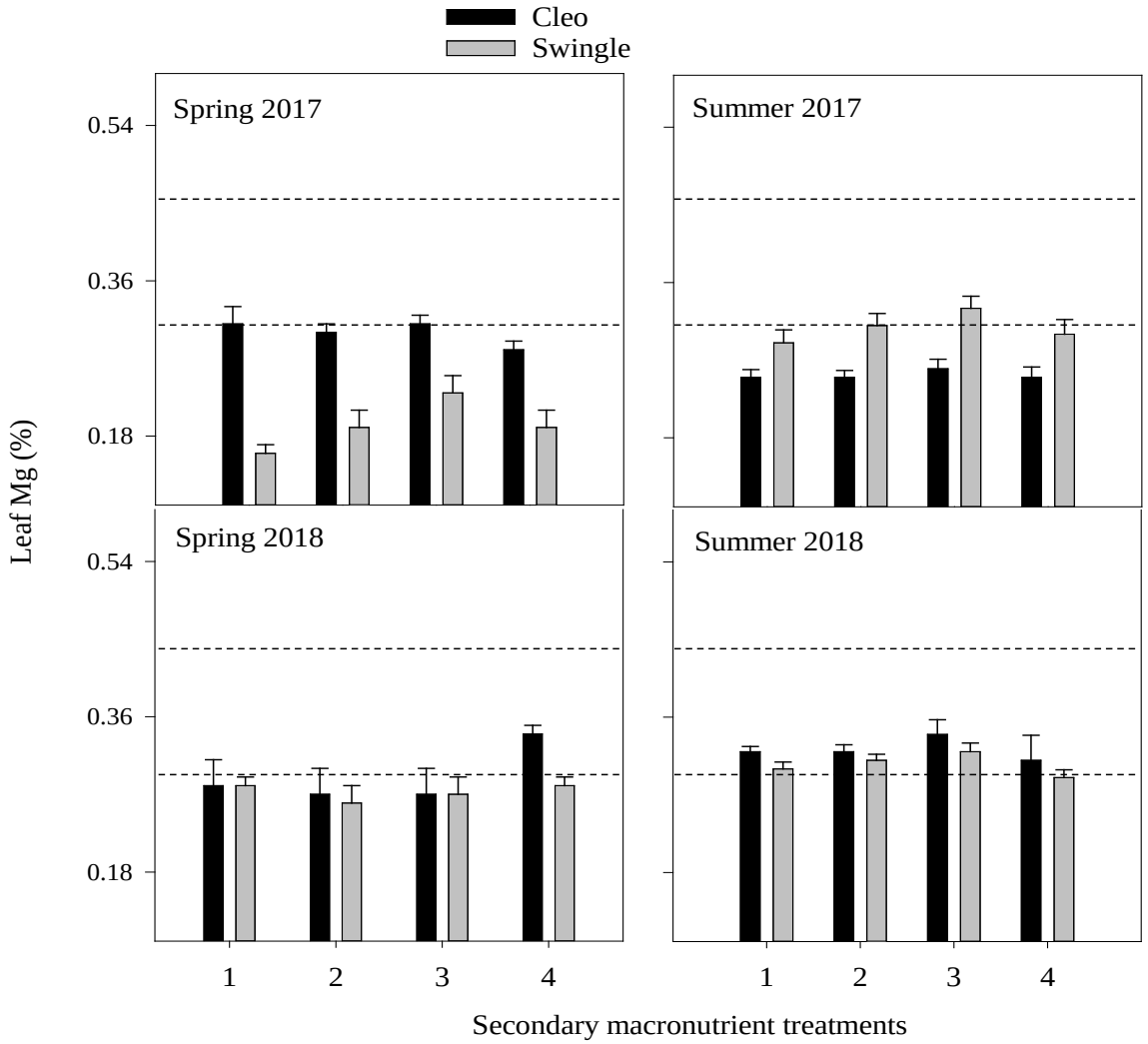
Effect of Magnesium on Leaf Concentration



Treatments (T):
control (T1),
full Ca dose (T2),
full Mg dose (T3), and
half Ca and half Mg doses (T4)

(Full dose=45 kg ha^{-1}).

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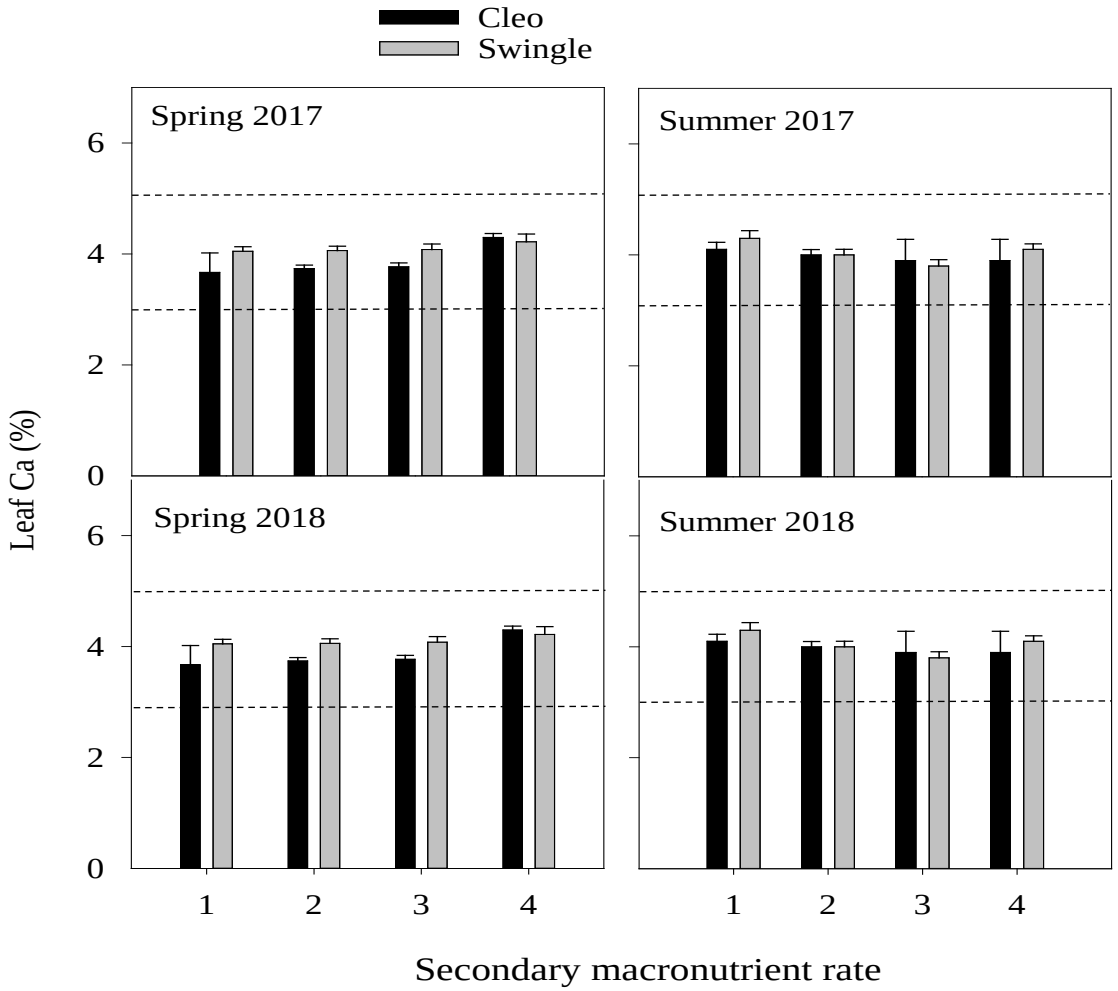
Effect of Magnesium on Leaf Concentrations



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(Full dose=45 kg ha^{-1}).

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Conclusions

- ✓ Soil pH affects crop plants ability to extract nutrients, including N, P, K, Mg, Ca, Mn, Zn
- ✓ Higher soil pH reduce plant nutrient uptake by reducing soil water nutrient solubility,
- ✓ Water and soil bicarbonates should be addressed to allow for proper nutrient uptake,
- ✓ Irrigation water acidification or application of acidifying fertilizer materials should be used to reduce soil pH in the irrigated area,
- ✓ Soil application of Ca and Mg improves leaf area and canopy volume but not leaf concentrations

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