Performance of HLB-affected orange trees under varying macro/micronutrient applications using frequent irrigation

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INTRODUCTION

Four Rs of nutrient management

Right time - meet plant nutrient demand

Right place - distance from and depth within the rootzone

Right source - solubility, application method

Right rate - amount, toxicity, induced deficiencies

Environmental concerns - leaching,

OBJECTIVES

- *To determine distribution patterns of selected macronutrients in the rootzone and effect on nutrient use efficiency.*

- *To determine uptake patterns of macro and micronutrients and relationships with tree performance.*

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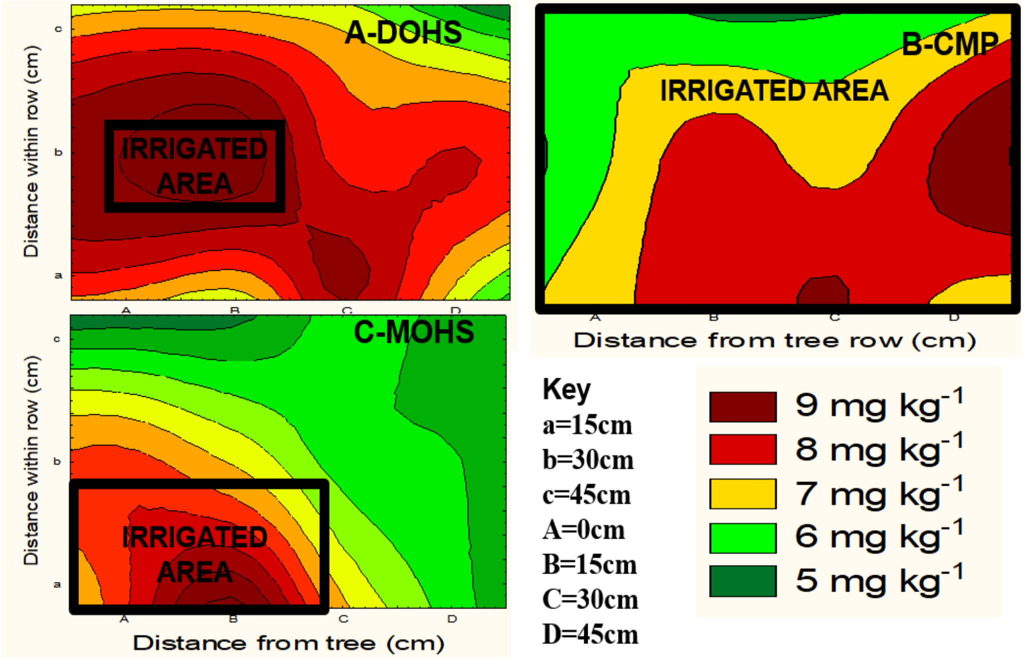
EFFECTS MACRONUTRIENTS – LESSONS FROM FIELD STUDIES

POTASSIUM DISTRIBUTION IN THE ROOT ZONE



CMP-Conventional microsprinkler irrigation
MOHS-Microprinkler open hydroponic system with daily irrigation and weekly fertigaton.
DOHS-Drip open hydroponic system with daily irrigation and fertigation.

Greater K concentration the irrigated/fertigated zone than non-irrigated zone in the 0-15 cm (0-6 inch) depth. Strong potential for nutrient uptake because root density was 4x-8x greater than non-irrigated zone.

Kadyampakeni et al. 2014. Soil Science Society of America Journal 78:325–334.

Potassium (K) distribution in the 0-15 cm depth

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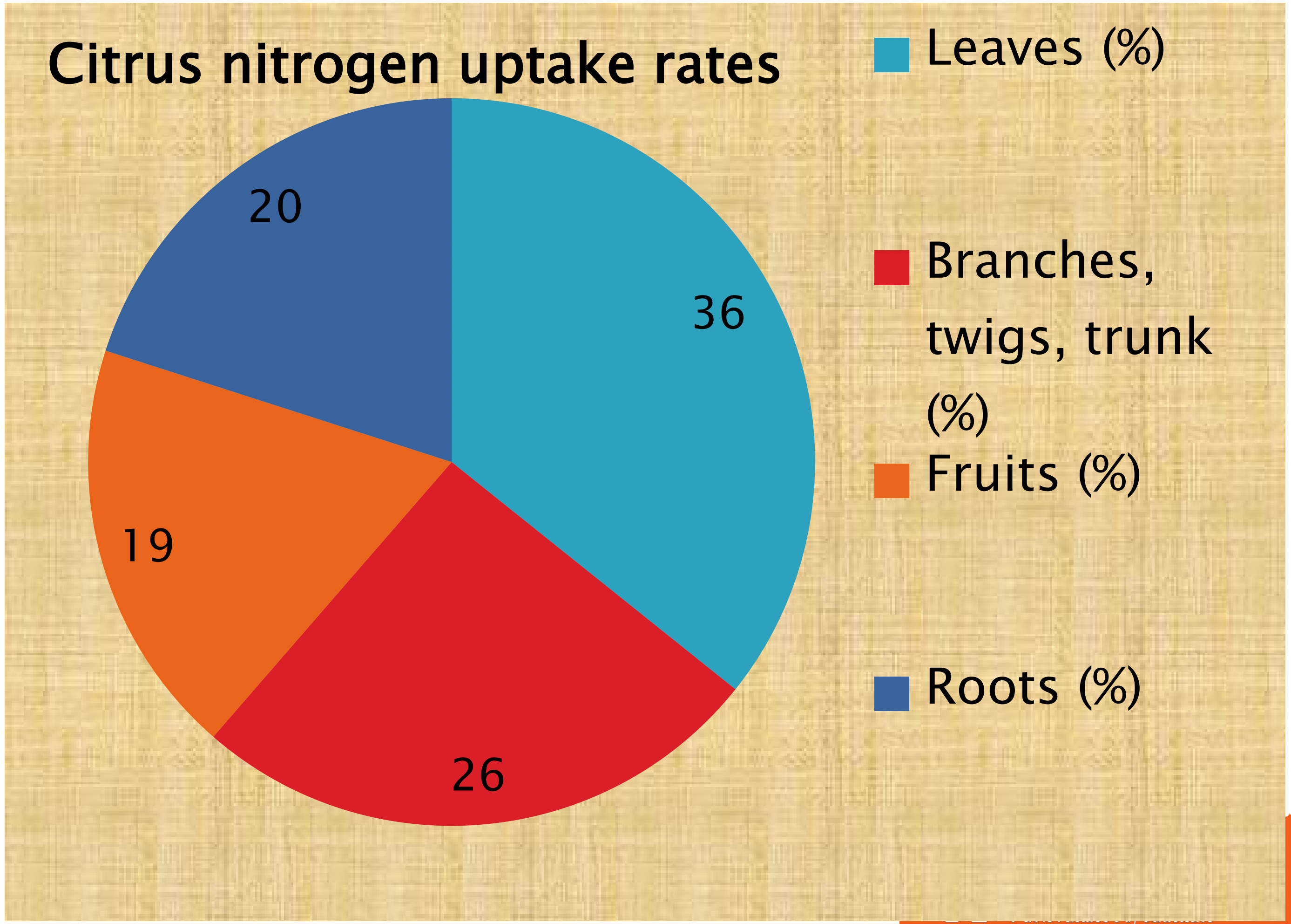
NITROGEN ACCUMULATION FOR HEALTHY TREES



Cameron and Appleman (1935); Cameron and Compton (1945); Feigenbaum et al. (1987); Quiñones et al. (2005); Legaz et al. (1982); Legaz et al. (1995) Quiñones et al. (2003)

N concentration follows the pattern: leaves>branches>roots>fruits

N AND P ACCUMULATION FOR HLB-AFFECTED TREES

Fertigation method	CMP	DOHS	MOHS	CMP	DOHS	MOHS
Tissue	N (kg ha^{-1})			P (kg ha^{-1})		
Leaves	24.0	49.8	37.1	1.3	1.7	1.5
Fruits	22.4	15.8	30.0	2.7	1.0	2.3
Branches and trunk	20.7	28.4	26.4	4.8	3.8	4.2
Roots	11.6	20.8	20.2	2.9	3.0	3.0
Total	78.70	114.8	113.7	11.7	9.5	11.0

DOHS–Drip open hydroponic system; MOHS–Microsprinkler open hydroponic system; CMP–Conventional microsprinkler practice

45% greater N accumulation with DOHS and MOHS than CMP at Immokalee but P accumulation similar for all practices.

Kadyampakeni et al. 2016. J. Plant Nutr. 39(5):589-599.

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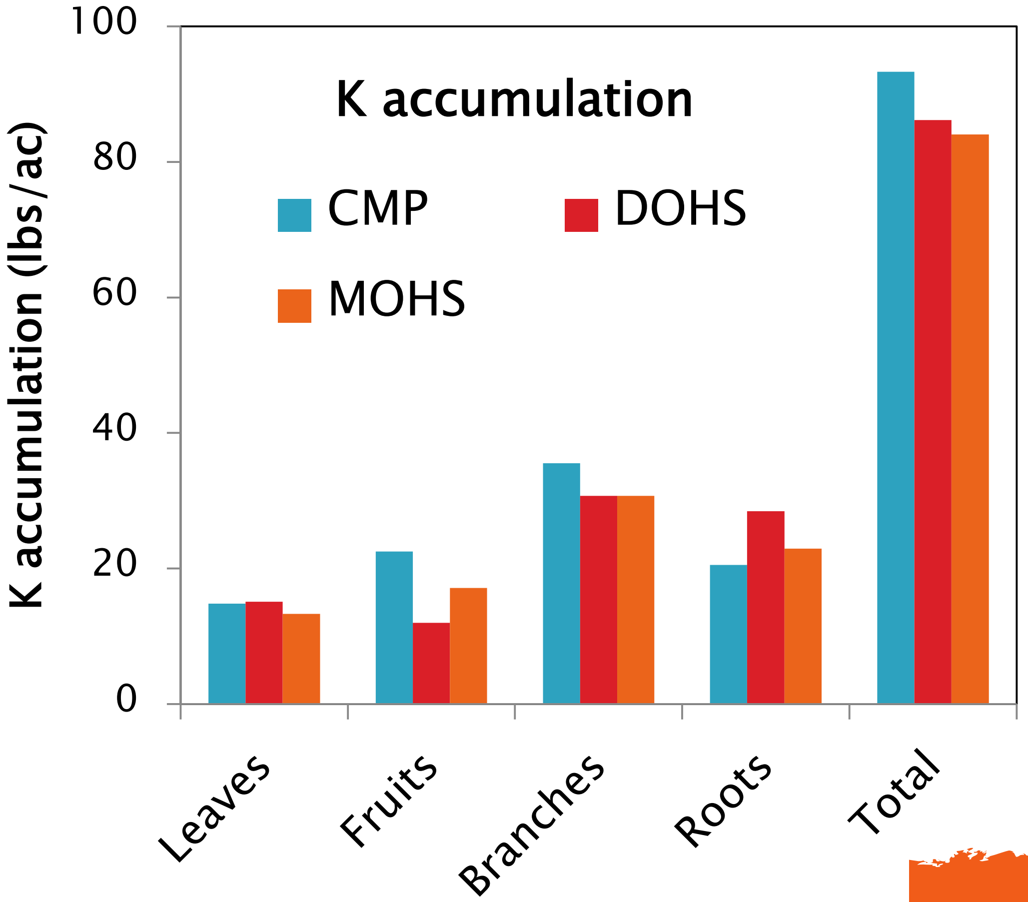
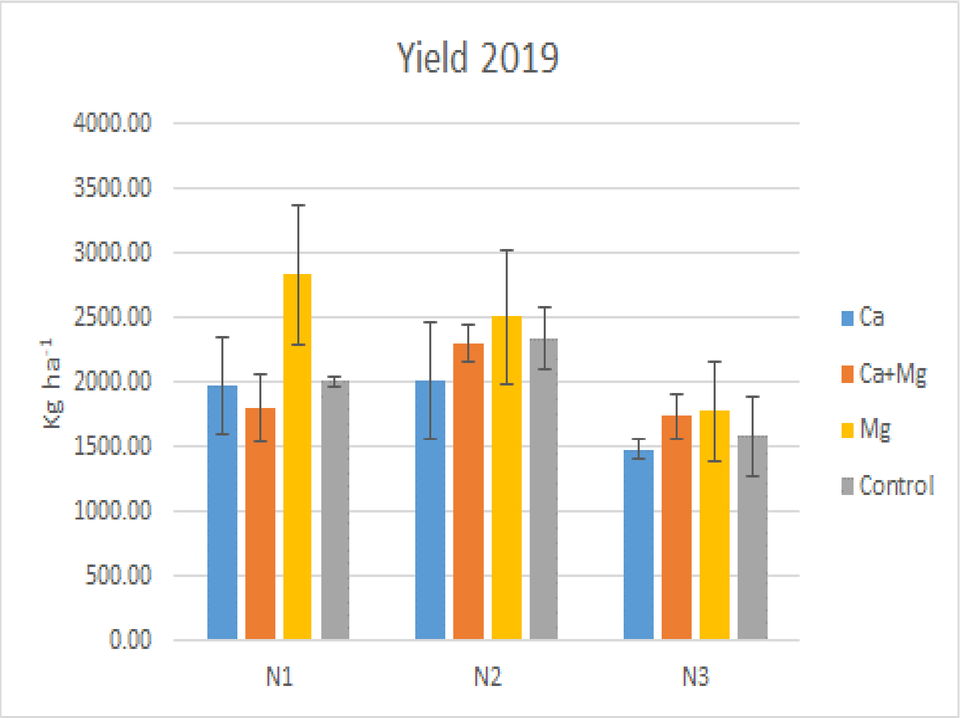
K ACCUMULATION FOR HLB-AFFECTED TREES



DOHS–Drip open hydroponic system
MOHS–Microsprinkler open hydroponic system
CMP–Conventional microsprinkler practice

- Greatest K accumulation in branches, twigs and trunk than other parts
- K accumulation in CMP>DOHS>MOHS

EFFECT OF CALCIUM AND MAGNESIUM OF YIELD OF HLB-AFFECTED TREES



Yield of Valencia orange on HLB-affected trees

Yield reported in kg ha^{-1}, 1 box= 40.8 kg

N1, N2, N3 refer to 150, 200 and 250 lbs N/acre

Sole Mg applied at 45 kg/ha

Sole Ca applied at 45 kg/ha

Combined Ca+Mg applied at 22.5 kg/ha

each in combination

Control received no additional Ca or Mg.

Yield differences observed at 150 lbs N/acre, with greater yield with sole Mg.

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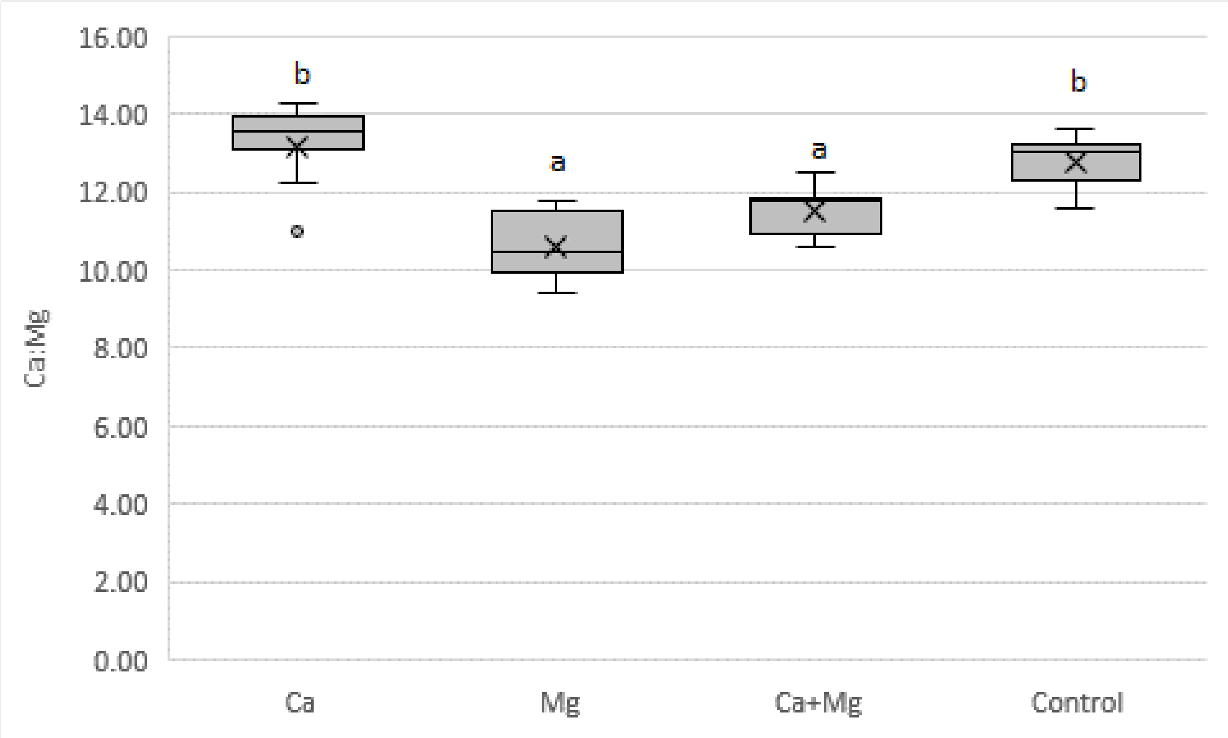
EFFECT OF CALCIUM AND MAGNESIUM OF LEAF CONCENTRATION OF HLB-AFFECTED TREES

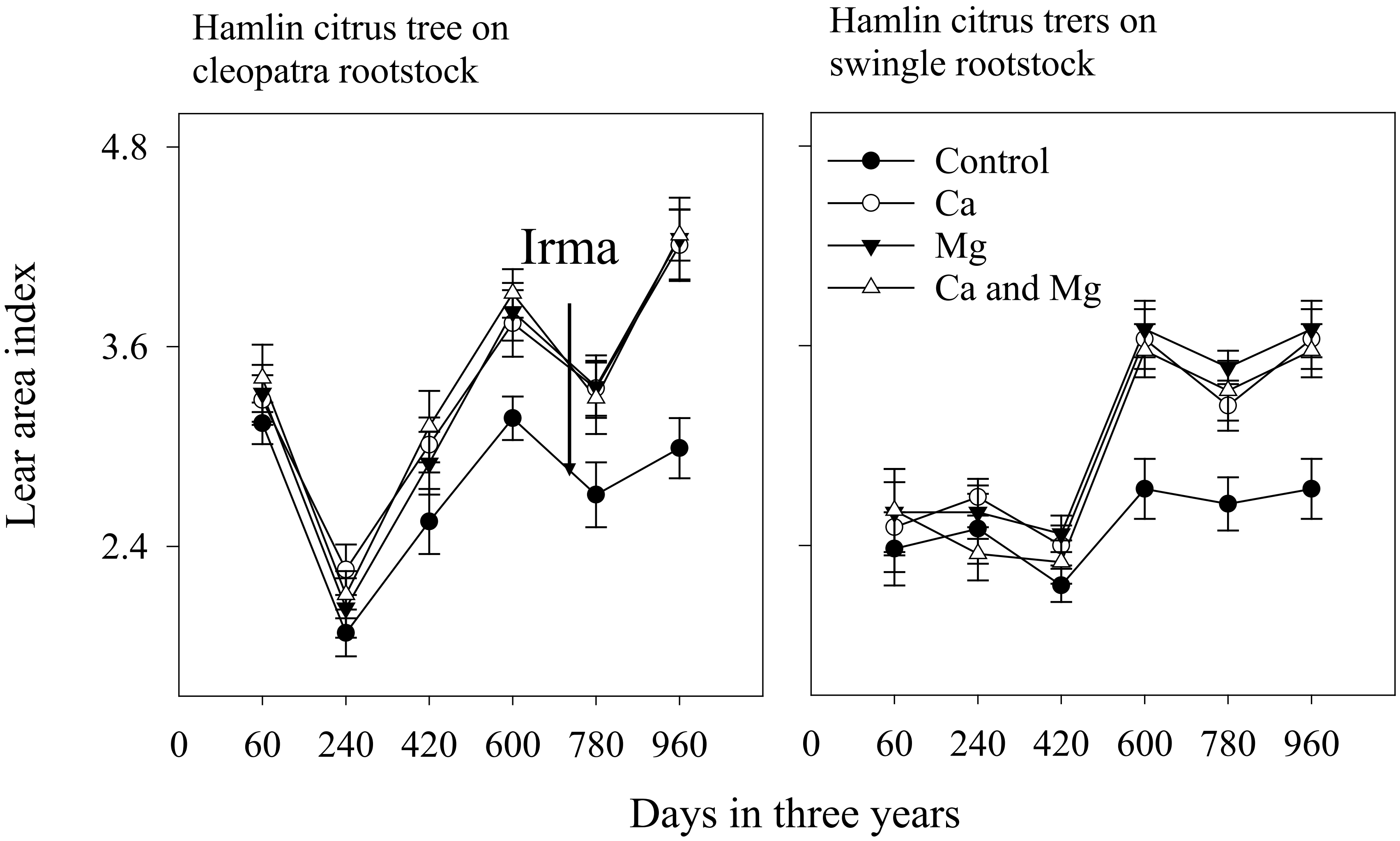


- Greater Ca:Mg ratio in Ca and control treatments Mg and Ca+Mg treatments.
- Background Ca was greater, thus response observed in controls.
- PH remained around 6.5 to 7.0 in all plots.

SOIL CALCIUM AND MAGNESIUM APPLICATIONS

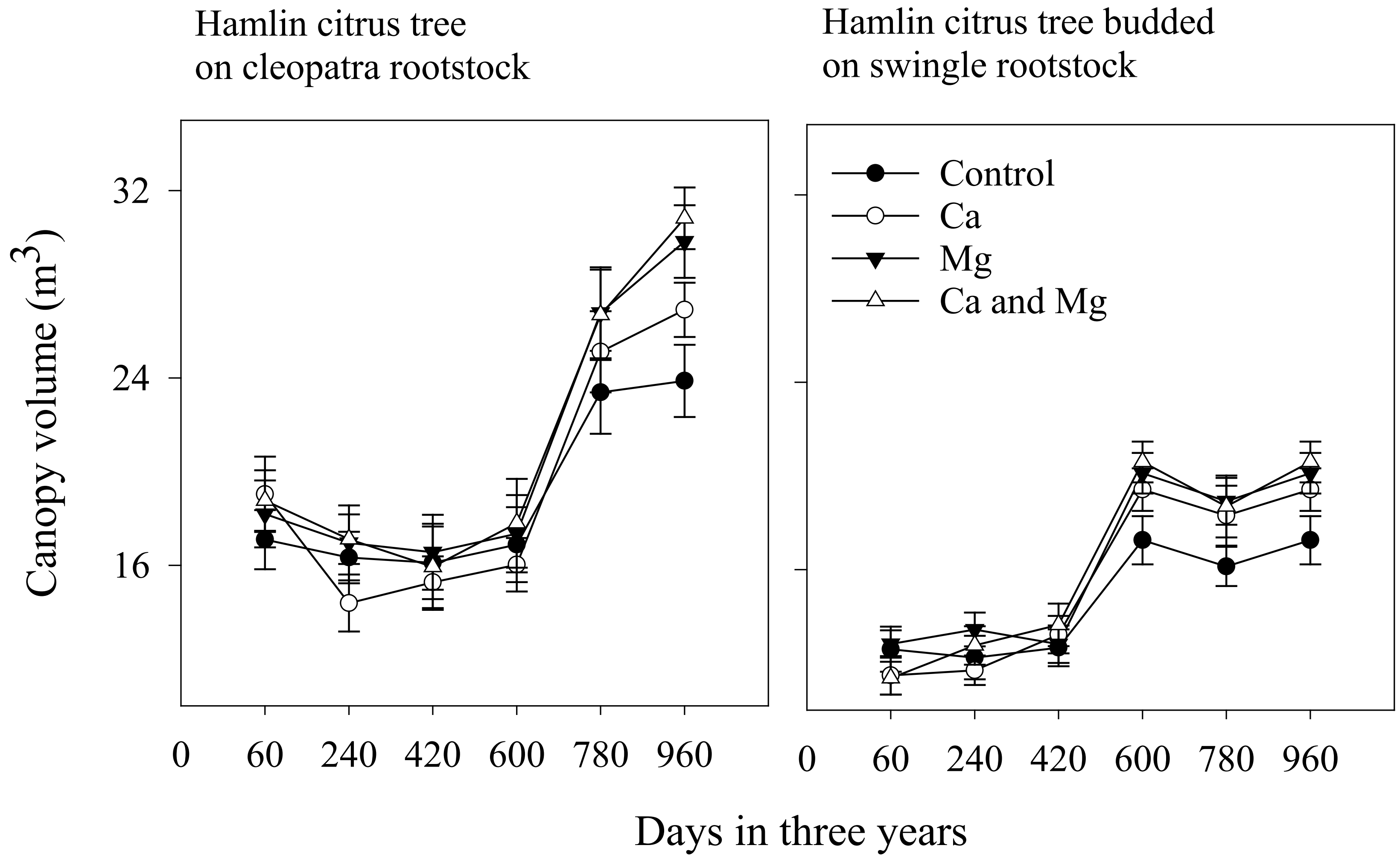
- **Study started in Jan. 2017, set as zero day of the three years study.**
- **10 year-old Hamlin on Cleo and Hamlin on Swingle**
- **Treatments (T): control (T1), full Ca dose (T2), full Mg dose (T3), and half Ca and half Mg doses (T4), (full dose=45 kg ha^{-1}).**

EFFECT OF CALCIUM AND MAGNESIUM ON LEAF AREA



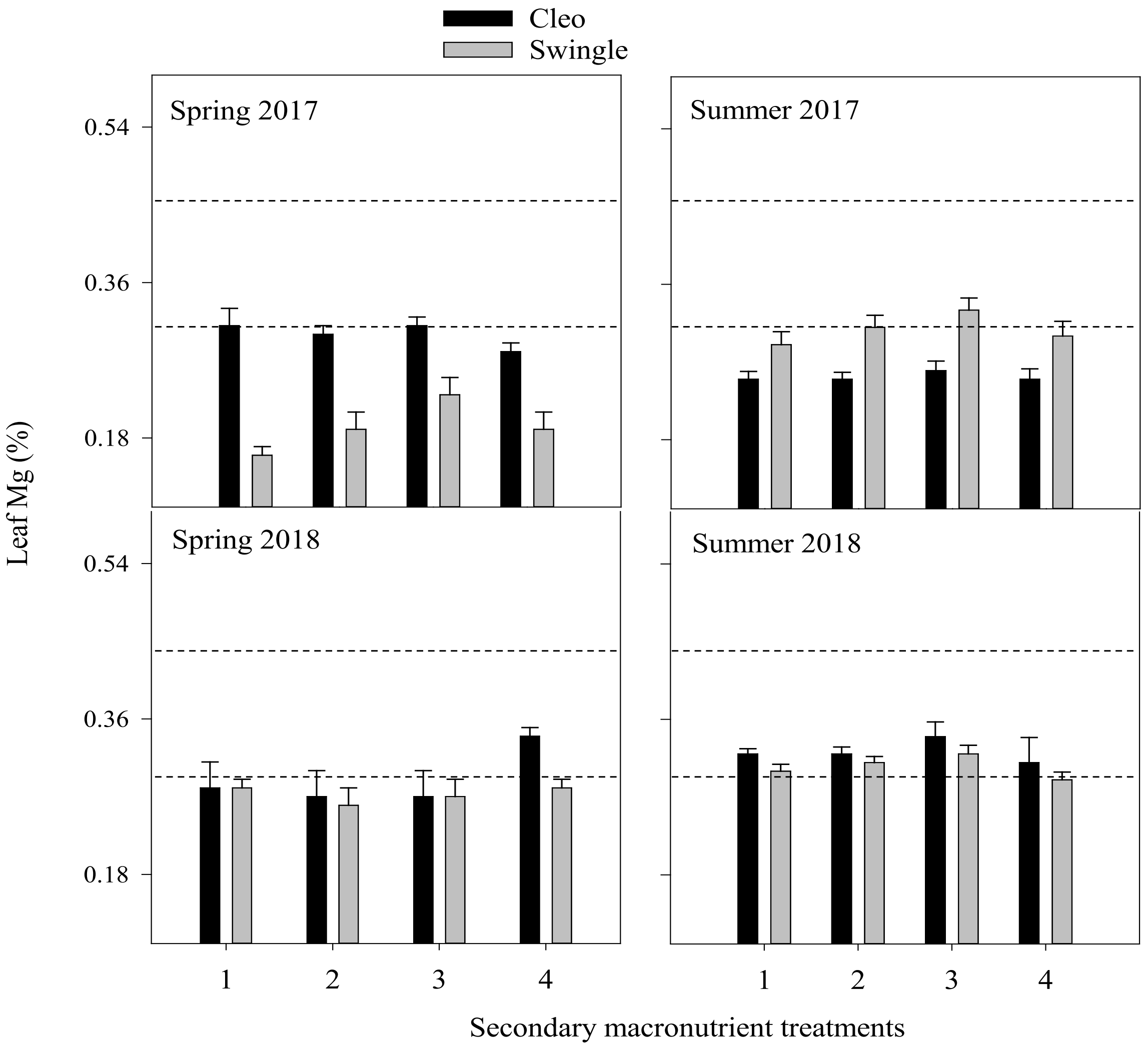
Improved leaf area index for Hamlin orange on the two rootstock with adjusted Ca, Mg and Ca+Mg over the control

EFFECT OF CALCIUM AND MAGNESIUM ON CANOPY VOLUME



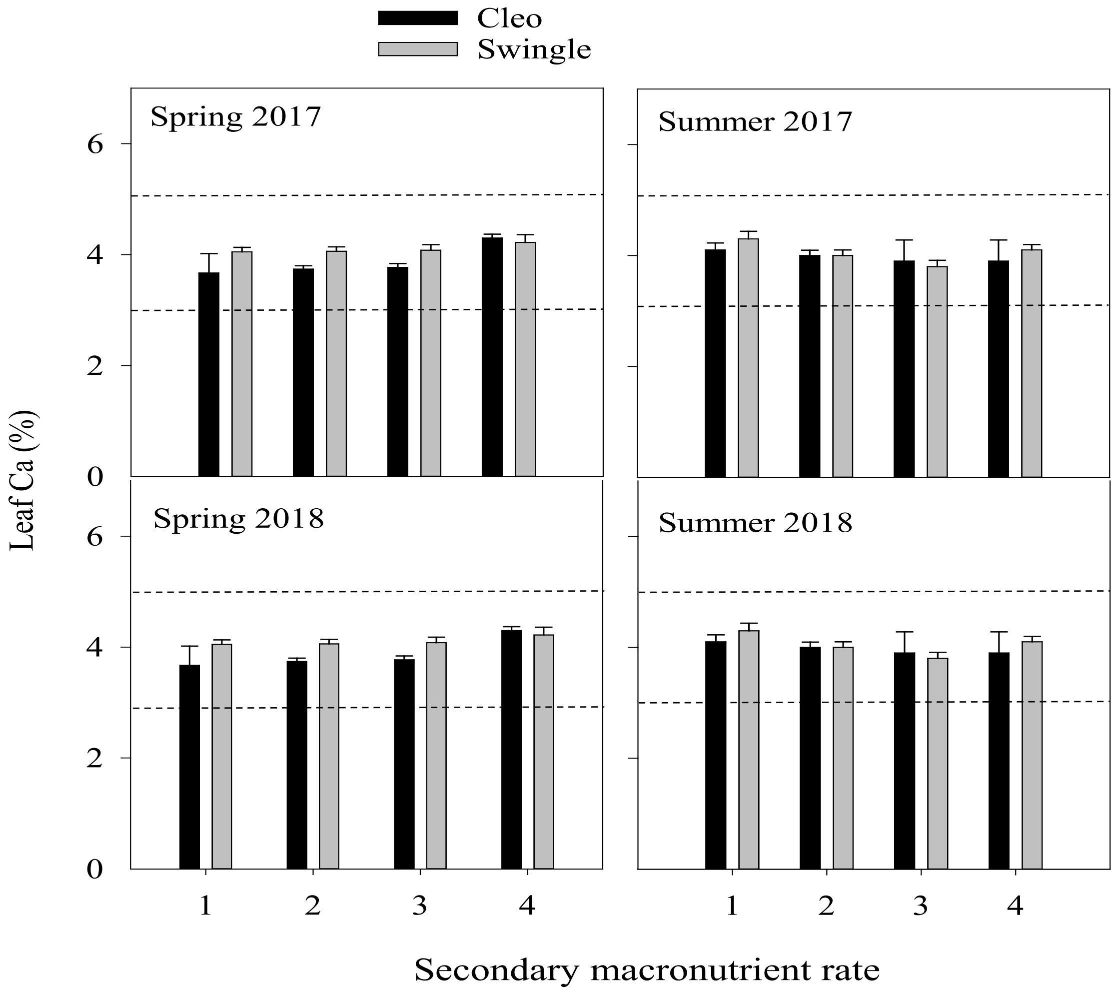
Improved canopy density for Hamlin orange on the two rootstock with adjusted Ca, Mg and Ca+Mg over the control

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}).

EFFECT OF CA ON LEAF CONCENTRATIONS



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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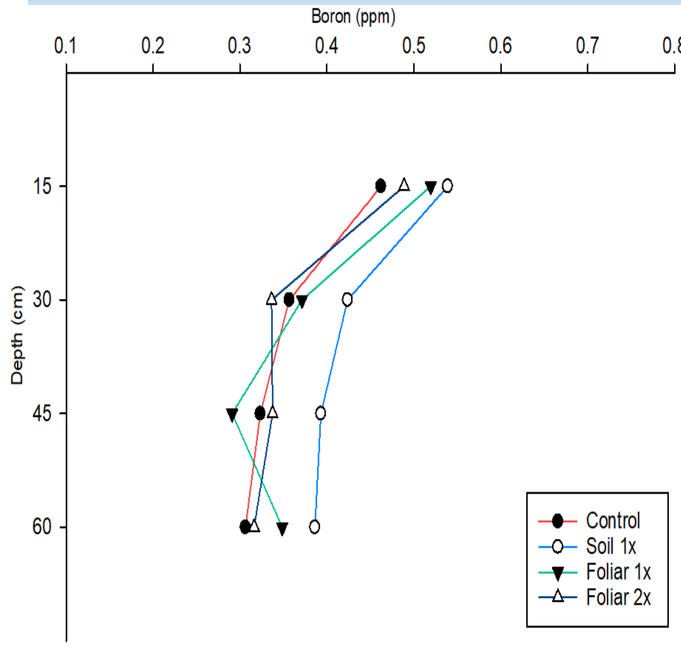
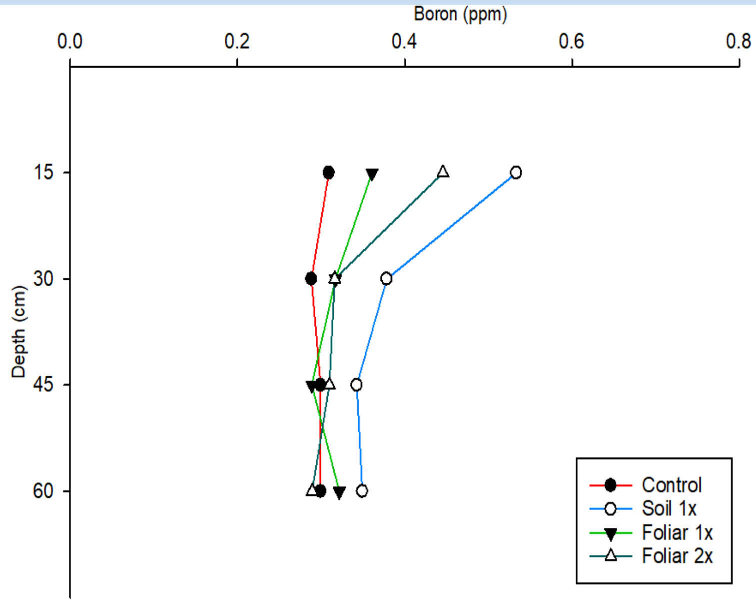
EFFECTS OF MICRONUTRIENTS ON HLB-AFFECTED TREES

SOIL BORON AVAILABILITY FOR HLB-AFFECTED TREES

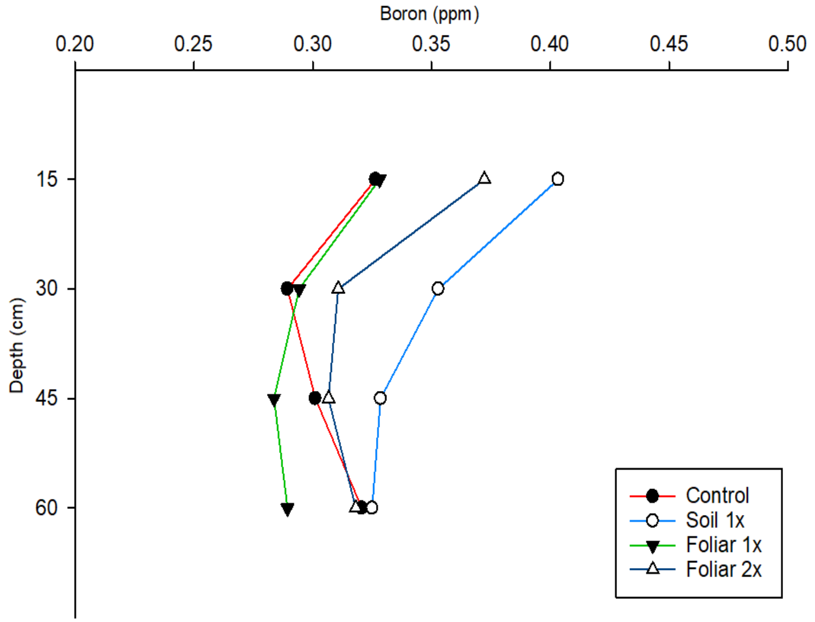
30 cm



60 cm



90 cm



B available mostly in the 15 cm, at 30 and 60 cm distance from the tree and could improve uptake efficiency.

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SOIL MICRONUTRIENT AVAILABILITY FOR HLB-AFFECTED TREES

Retardation factor (R) of B, Mn and Zn at field capacity and saturation

Soil depth	$R(\theta_s)$			$R(\theta_{FC})$		
	B	Mn	Zn	B	Mn	Zn
0-15	1.38	9.34	25.54	3.23	50.03	145.19
15-30	1.14	1.59	13.12	1.50	3.17	45.81
30-45	1.16	1.41	1.21	1.64	2.61	1.81
45-60	1.13	1.38	1.21	1.54	2.63	1.91

Zinc and manganese are strongly held in the rooting zone and might be available or unavailable depending on soil moisture conditions and pH. Boron might leach easily. Regular foliar fertilization is desirable for all the nutreints depending on leaf analysis.

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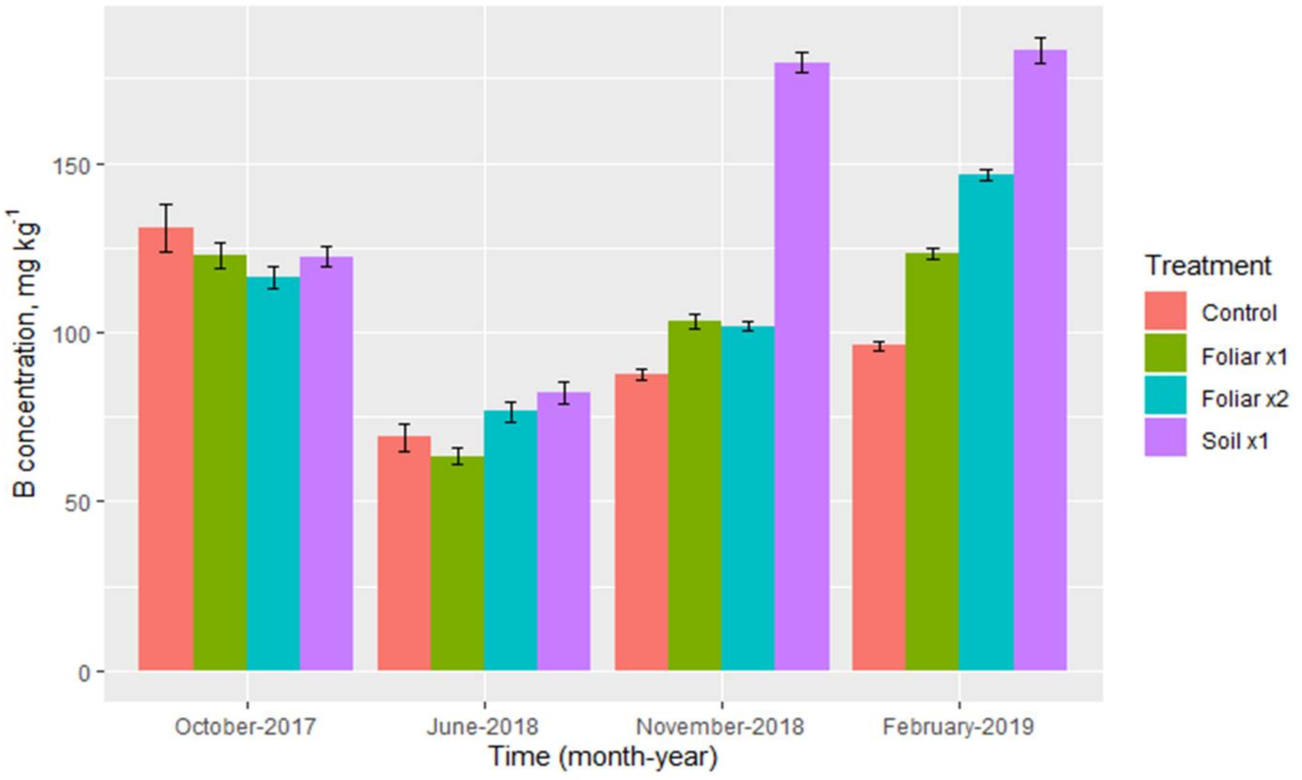
LEAF BORON CONCENTRATION OVER TIME IN HLB-AFFECTED CITRUS



Variability in leaf concentration of boron in response to seasons and treatments. Treatments are:

1) no nutrient applied (control),
2) foliar-applied B based at 1x UF/IFAS recommendation,
3) 2x foliar applied UF/IFAS recommendation, and
4) 2x soil applied UF/IFAS recommendation (1x = 1.12 kg B ha^{-1}).

Error bars denote 95% confidence intervals.

B concentration was between 60 and 90 ppm as a result of soil and foliar application of B uptake efficiency. Mn and Zn followed similar pattern. Soil application (1x IFAS) resulted in greater concentration over 1x and 2 x foliar application rate.

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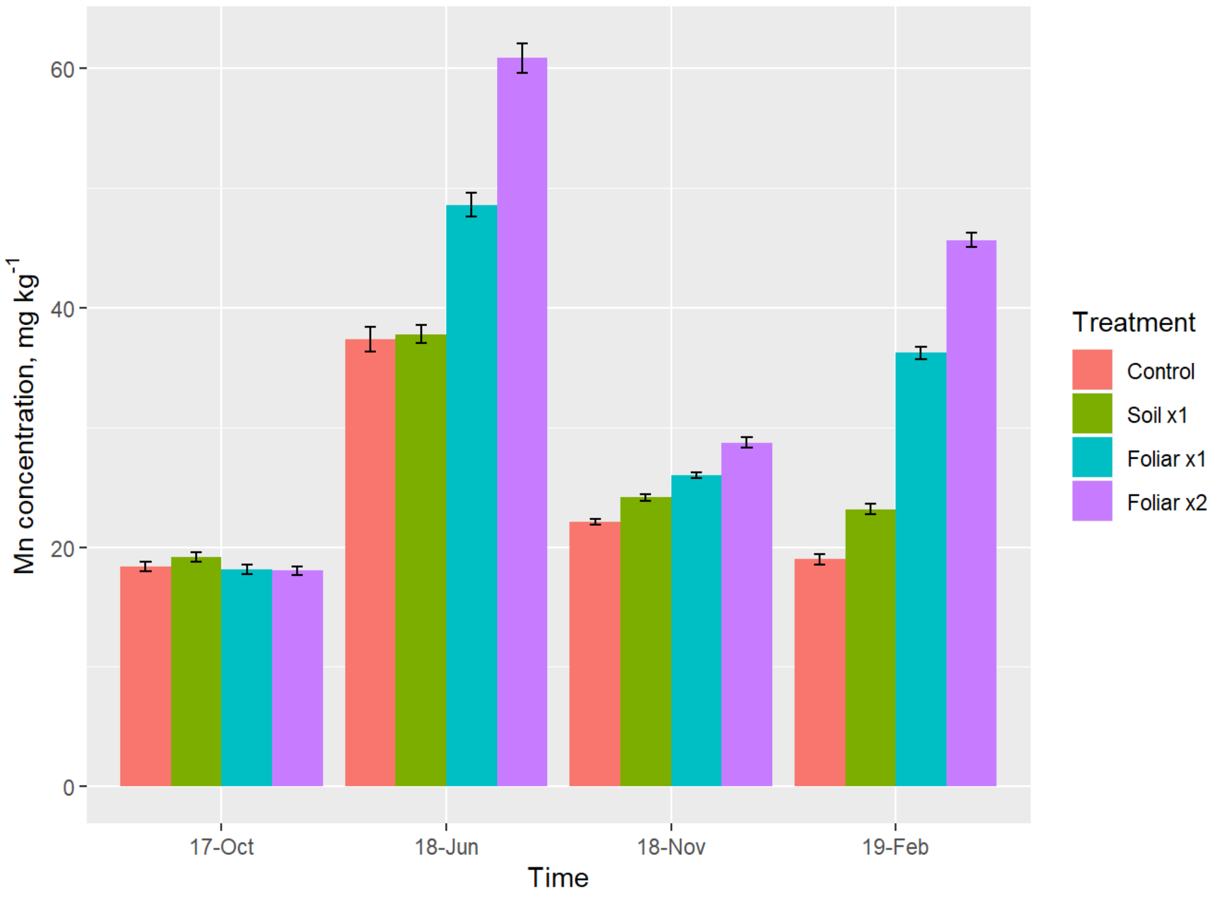
LEAF MANGANESE CONCENTRATION OVER TIME IN HLB-AFFECTED CITRUS



Variability in leaf concentration of Mn in response to seasons and treatments. Treatments are 1) standard soil Mn applied (control), 2) standard soil Mn applied + foliar applied Mn based at 1x IFAS recommendations + 1x standard soil nutrient application, 3) 2x foliar applied Mn UF/IFAS recommendations+ 1x standard Mn application, and 4) 2x soil applied UF|IFAS recommendations (1x = 10.08 kg Mn ha^{-1}). Error bars denote 95% confidence intervals.

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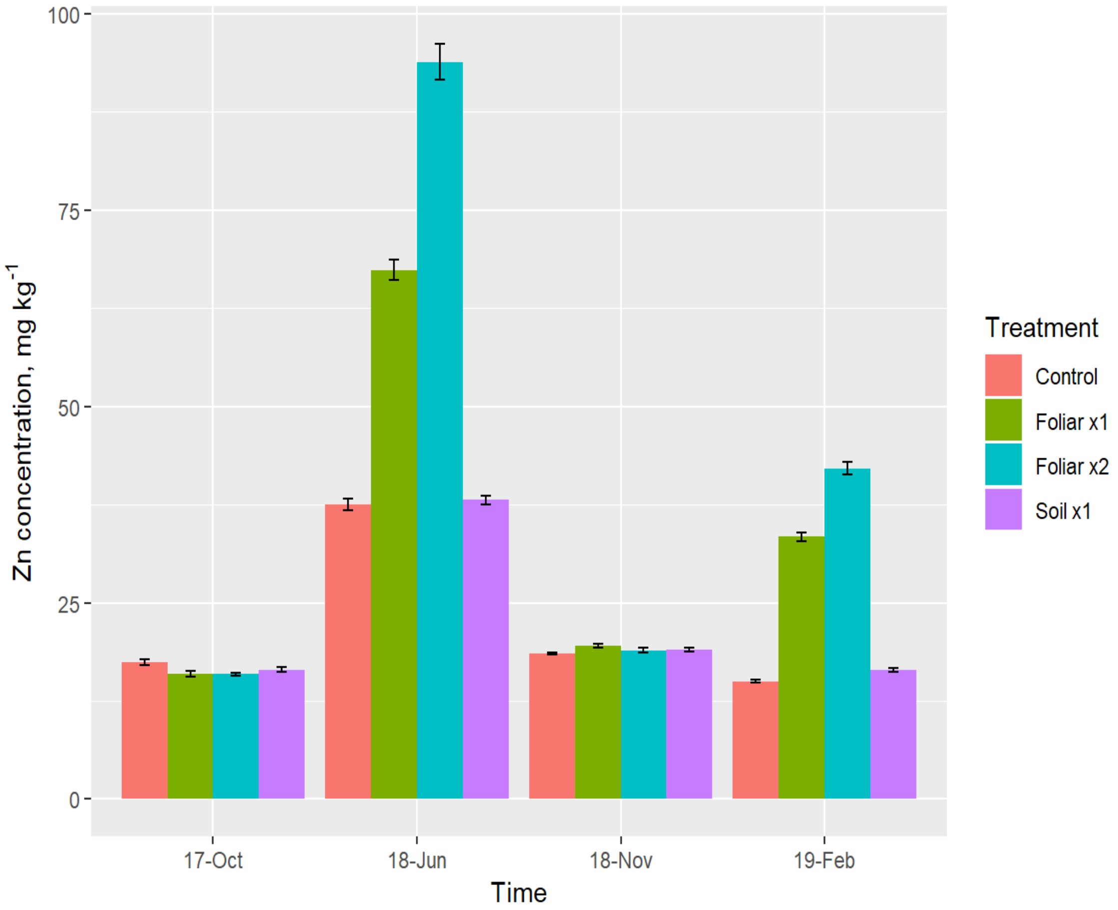
LEAF ZINC CONCENTRATION OVER TIME IN HLB-AFFECTED CITRUS



Leaf concentration of Zn in response to seasons and treatments. Treatments are 1) standard soil Zn applied (control), 2) foliar applied Zn based at 1x IFAS recommendations + 1x standard soil nutrient application, 3) 2x foliar applied Zn UF/IFAS recommendations+ 1x standard Zn application, and 4) 2x soil applied UF/IFAS recommendations (1x = 5.60 kg Zn ha^{-1}). Error bars denote 95% confidence intervals.

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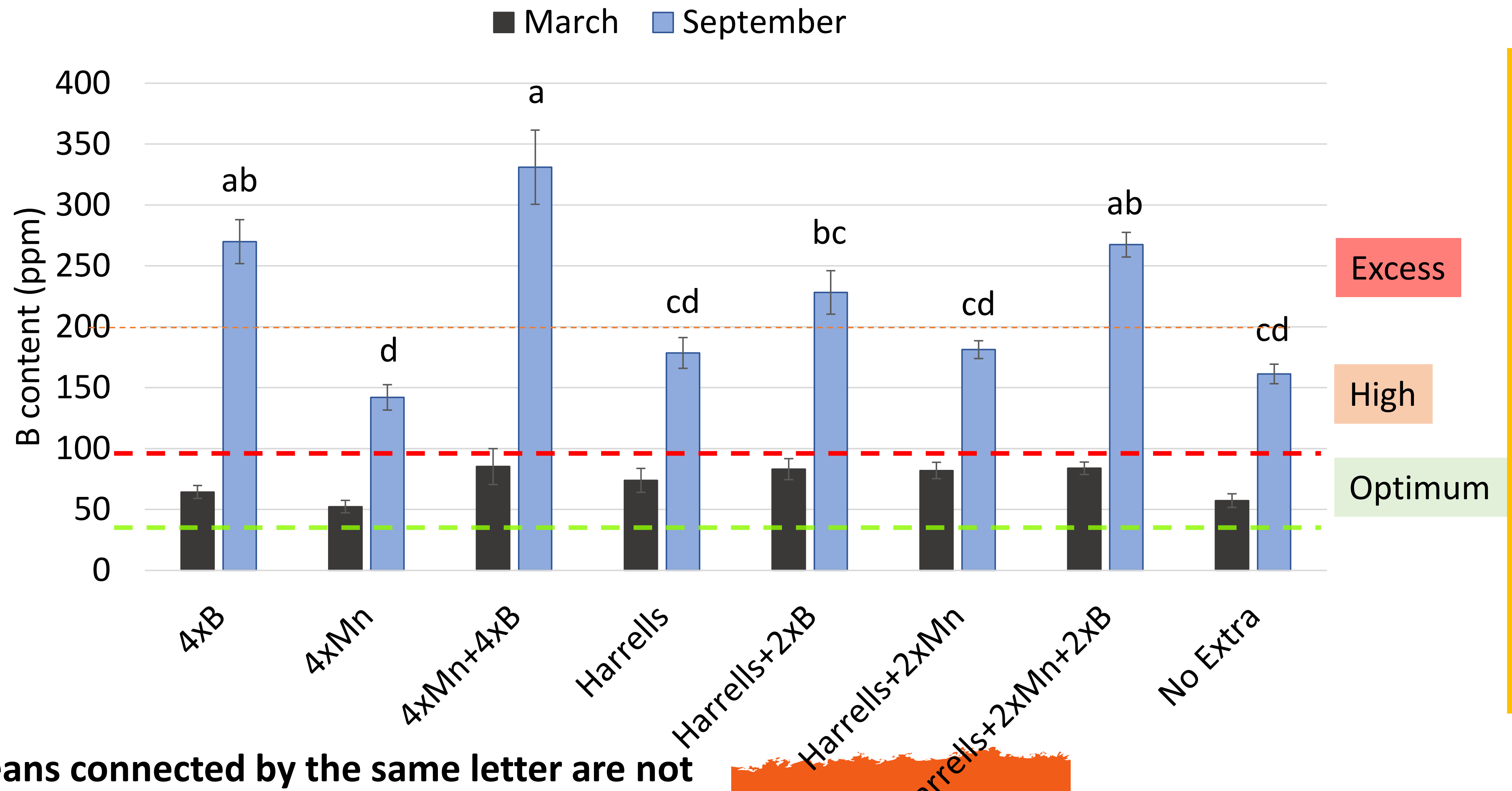
LEAF NUTRIENT CONTENT (B)



0x B (or residual boron) up to 2xB keep B between in the range 150 to 250 ppm, but 4xB was excessive, in spring flush. ***Kadyampakeni, 2020***

Means connected by the same letter are not significant different; Tukey's HSD with P=0.05

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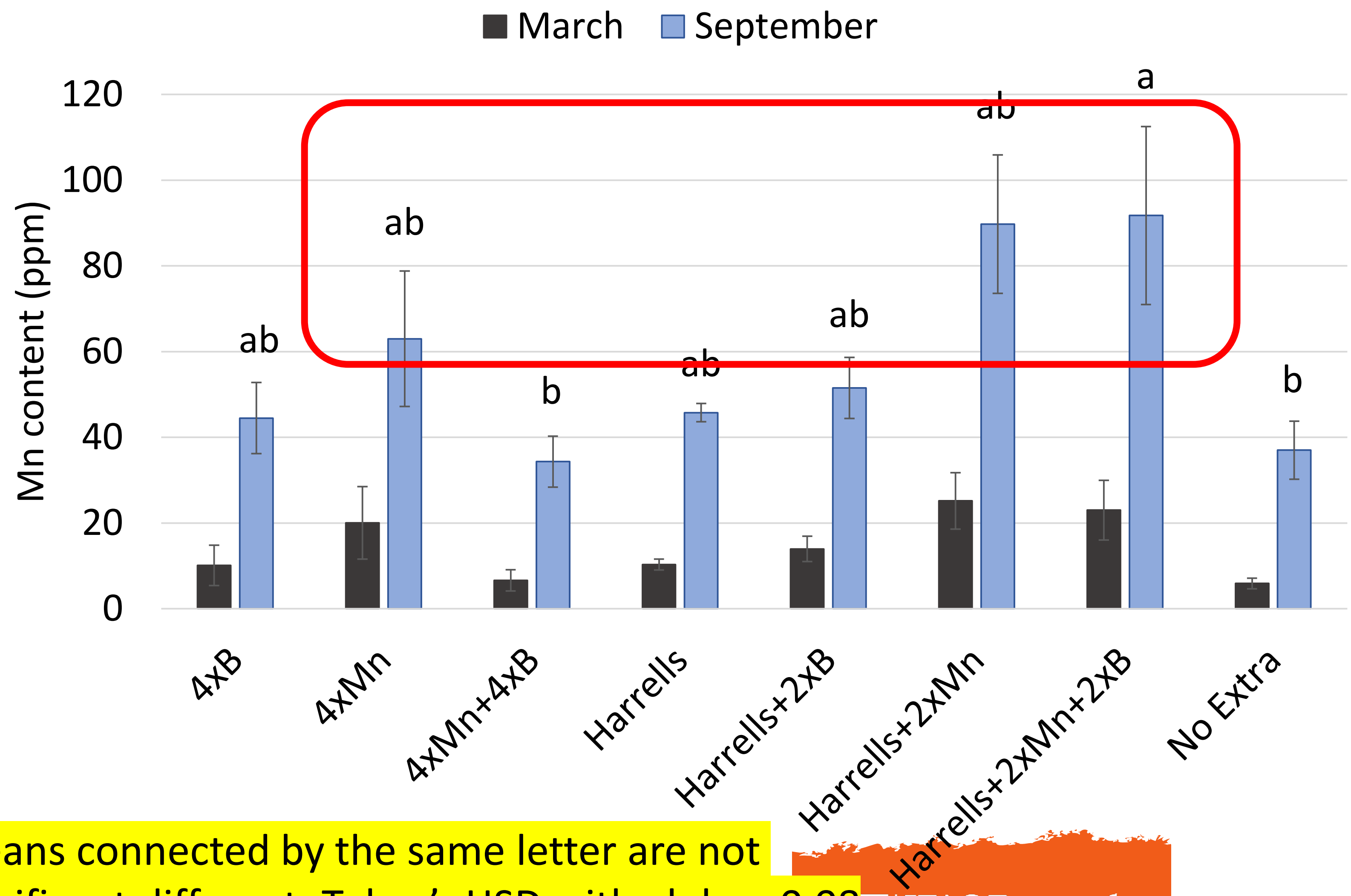
LEAF NUTRIENT CONTENT (MN)



Means connected by the same letter are not significant different; Tukey's HSD with alpha= 0.08

Comparison of elevated Mn treatments on 8-year old Vernia sweet orange on rough lemon rootstock showed optimum leaf concentration with 2xMn and 4xMn. Antagonistic uptake was observed between Mn and B when both applied at 4x. **2x-4xMn kept Mn between 60 to 120 ppm in the spring flush leaves.** Need to adjust fertilization by season, March Mn leaf concentration was fairly low. No differences were observed in canopy.

Zambon et al. 2019.

SUMMARY

- **Critical 4Rs for nutrient stewardship include: right rate, right source, right time and right place.**

- **Optimal and balanced nutrient management is important for high nutrient use efficiency and minimizing leaching losses.**

- **Good nutrient management is critical for promoting tree performance including denser canopy, high yields and LAIs under HLB conditions.**

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- UF/IFAS IRREC: Dr. Rhuanito Ferrarezi
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- Graduate students: Qudus Uthman, Eduardo Esteves, Tanyaradzwa Chinyukwi, Samuel Kwakye
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QUESTIONS/COMMENTS?

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