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Delineation of Soil Management Zones: Comparison of Three Proximal Soil Sensor Systems under Commercial Potato Field in Eastern Canada.

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Introduction

- Potato crops (*Solanum tuberosum* L.) are recognized as good candidates for the adoption of PA because of the high cost of inputs, high variability of soil and crop and the high-value of the crop is based on yield and quality (Cambouris et al. 2014).
- Apparent soil electrical conductivity (EC_a) measured by electromagnetic induction is temporally stable and strongly related to inherent soil properties (Cambouris et al. 2006).
- The ground penetrating radar (GPR) is a proximal sensor that can be used to map soil attributes of importance for agriculture and natural resource management (Adamchuk *et al.*, 2015).

Objective

To evaluate the efficiency of three proximal soil sensors (electrical, electromagnetic and radiometric) to delineate MZ linked to soil physicochemical properties and tuber yield maps.

Materials & Methods

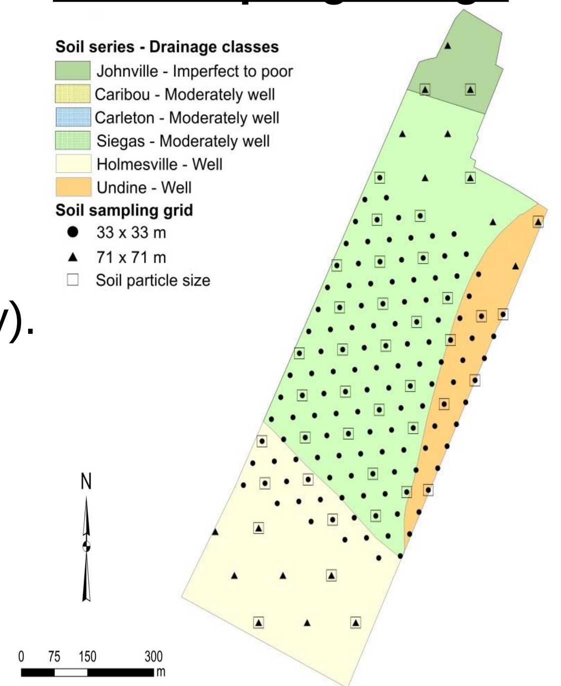
Site description:
- St. André, New Brunswick;
- Area: 21 ha.

Soil sampling and analyses:
- 0-15 cm;
- n = 154: Extractable M3 nutrients, pH, total C and N;
- n = 41: particle size (sand, silt, clay).

Grid size:
- 33 m x 33 m and 71 x 71 m.

Tuber Yield Monitor
- Potato harvester yield monitor (RiteYield system, Greentronics, Elmira, ON, Canada): 2013, 2014 and 2016.

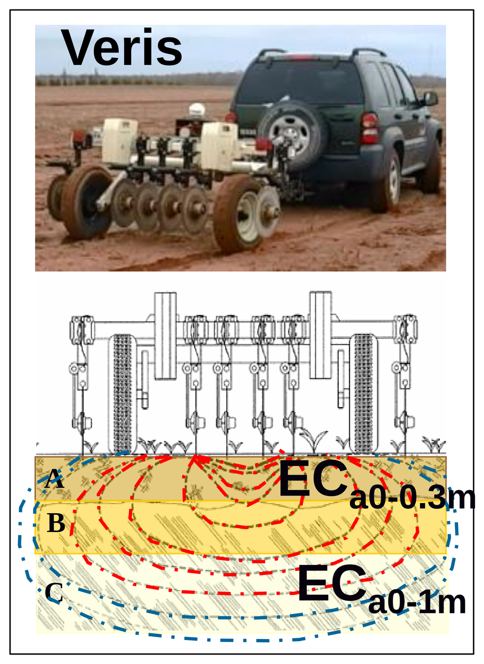
Soil map (1: 50 K) and sampling design



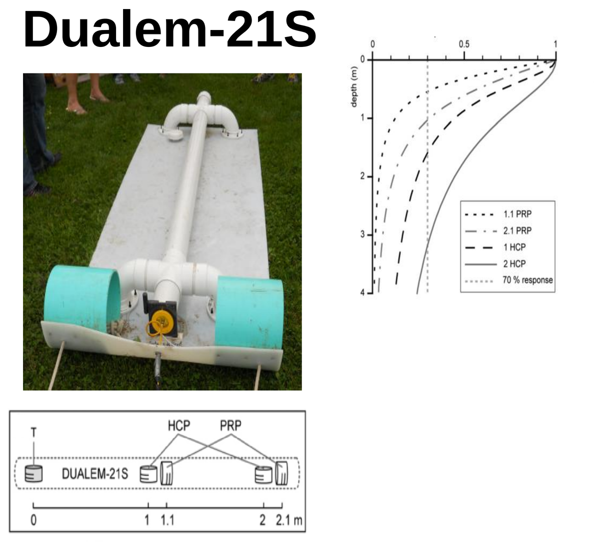
(Langmaid et al. 1980)

Proximal Soil Sensing systems:

Veris

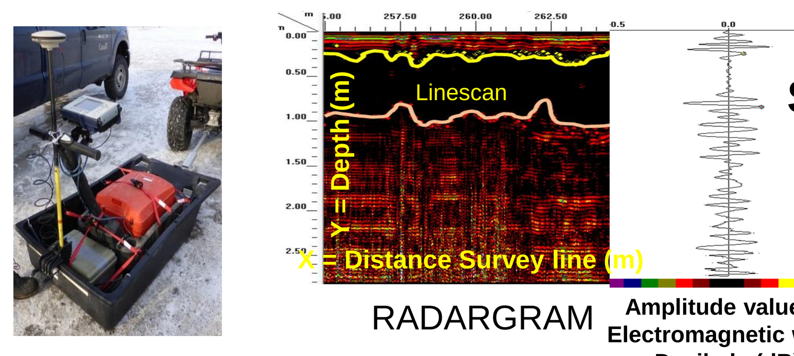


Dualem-21S



*$HCP_{V0-1.4m}$
$HCP_{V0-3.1m}$
$PRP_{P0-0.4m}$
$PRP_{P0-0.9m}$

* HCP: Horizontal co-planar
PRP: Perpendicular co-planar



SLT_S
SLT_{SS}
DBR

SLT_S: Soil layer tickness surface
SLT_{SS}: Soil layer tickness subsurface
DBR: Depth to bedrock

GPR: Ground penetrating radar

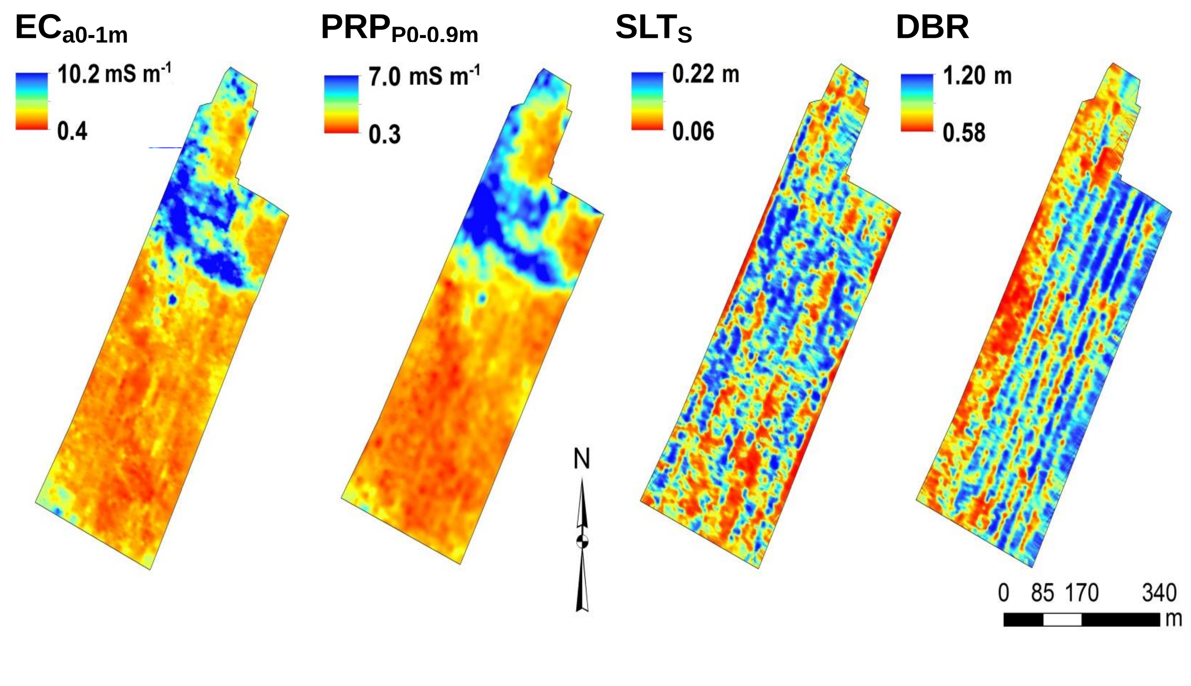
Results and discussion

Semivariogram analyses

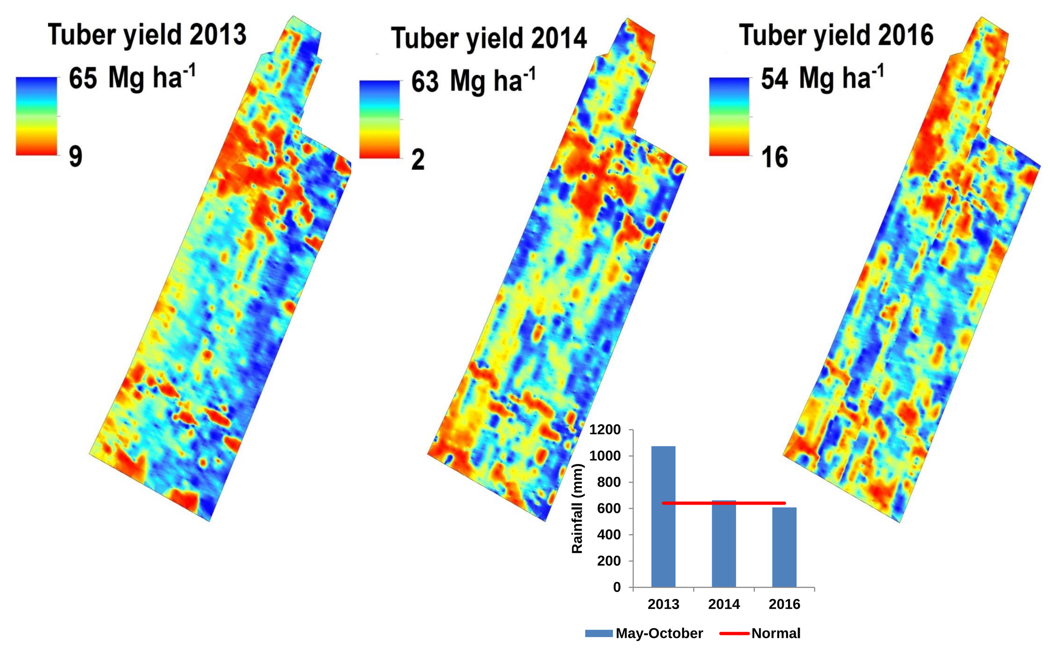
Model[z]		Nugget ratio,%	Spatial class	Range (m)	R^2_{CV}
Soil proximal sensors properties					
EC_{a0-1m}	Exp.	8.3	Strong	59	0.94
$PRP_{P0-0.9m}$	Sph.	19.8	Strong	50	0.94
SLT_S[y]	Exp.	37.0	Strong	27	0.95
DBR[x]	Sph.	33.0	Strong	18	0.37
Total tuber yield					
2013	Exp.	19.2	Strong	39	0.82
2014	Exp.	1.2	Strong	39	0.92
2016	Exp.	11.4	Strong	29	0.82

[z]: Exp., exponential; Sph., spherical. [y]; SLT_S, soil layer thickness surface; [x]: DBR, depth to bedrock.

Soil proximal sensors maps

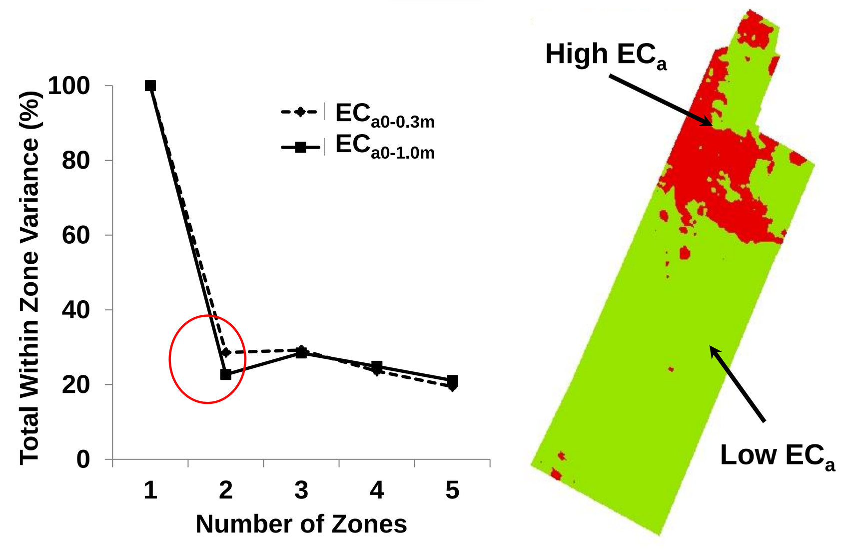


Total Tuber yield maps



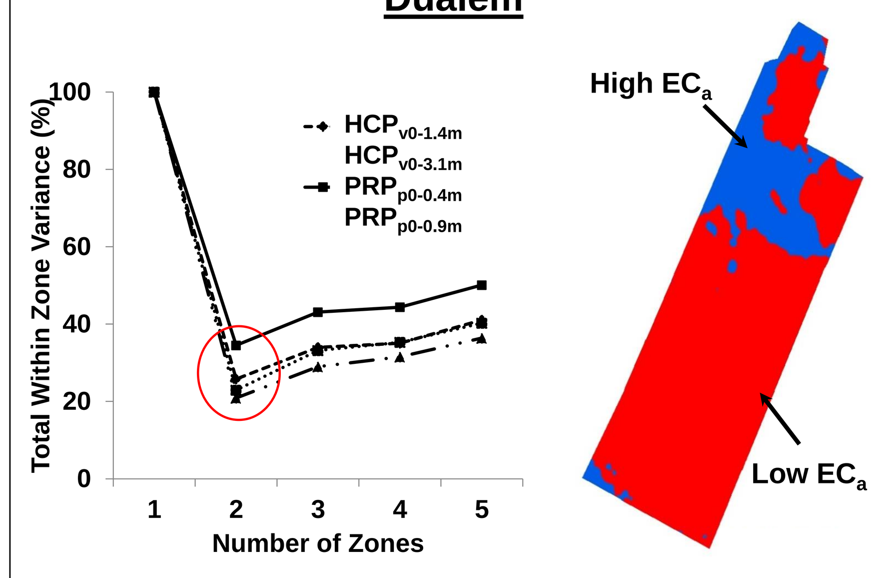
Determination of the optimum number of mangement zones with soil proximal sensors

Veris



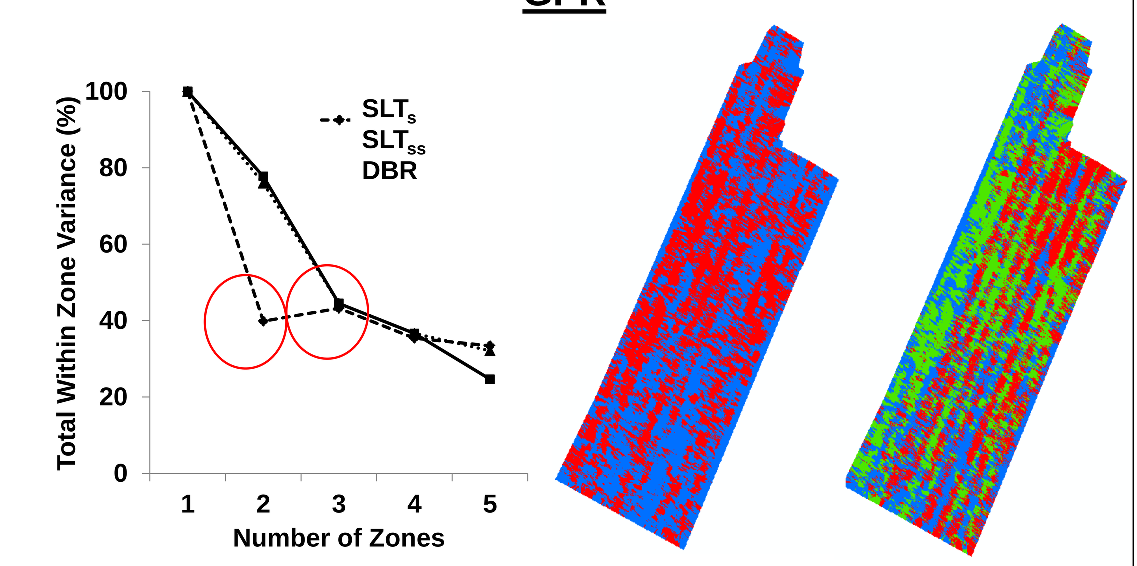
Soil EC_a is significantly different within the 2 MZ.

Dualem



Soil EC_a is significantly different within the 2 MZ.

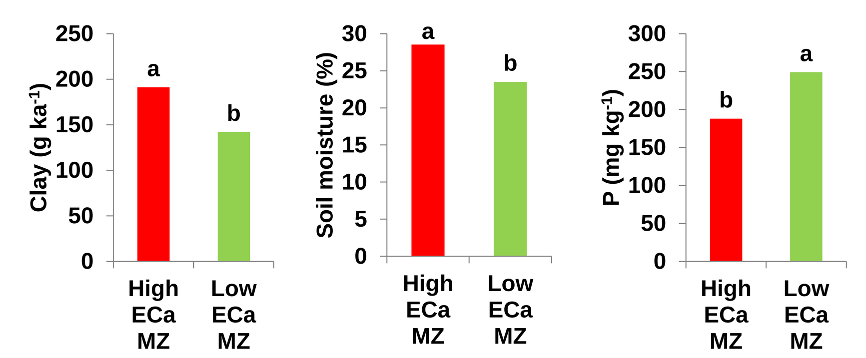
GPR



No significant difference of SLT and DBR within the 2 MZ.

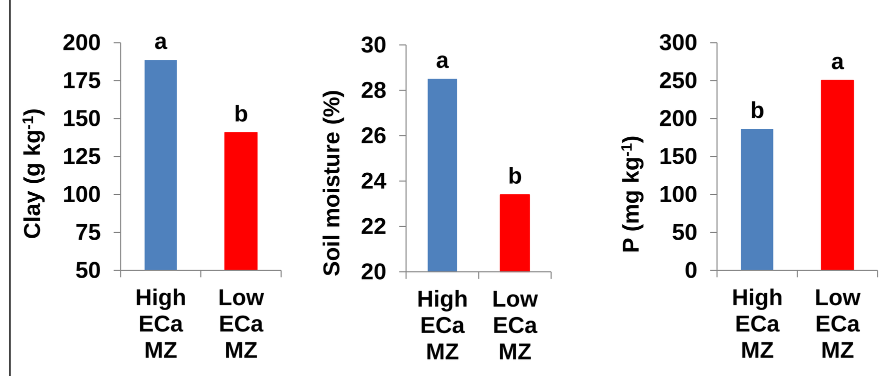
Validation of the management zones with selected soil properties

Veris MZ



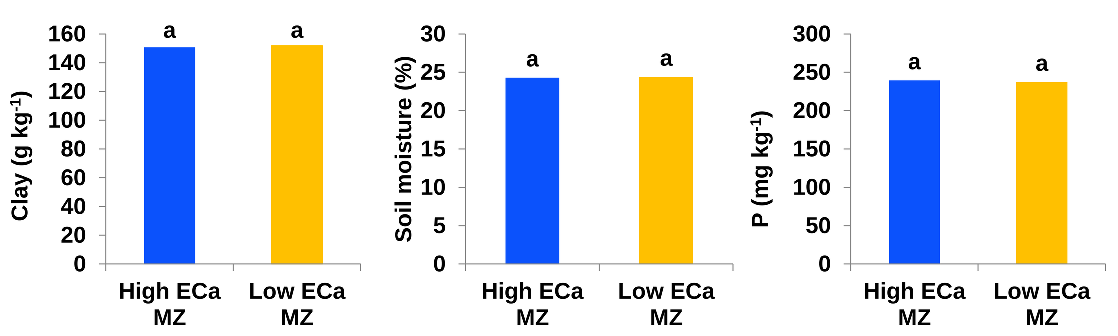
↑ ECa = ↑ Clay, ↑ moisture, ↓ P

Dualem MZ



↑ ECa = ↑ Clay, ↑ moisture, ↓ P

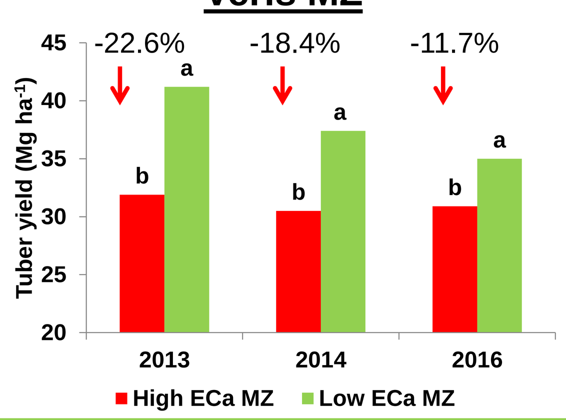
GPR MZ



GPR: No significant difference

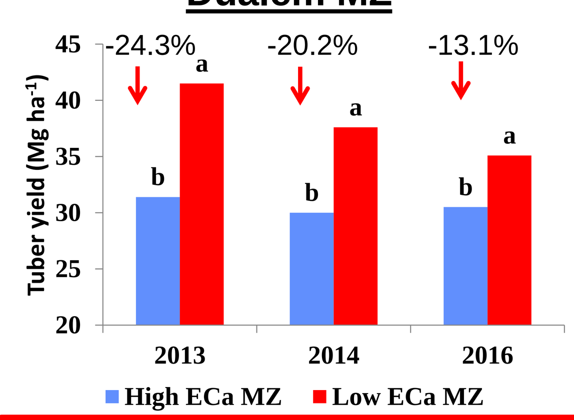
Validation of the management zones with total tuber yield

Veris MZ



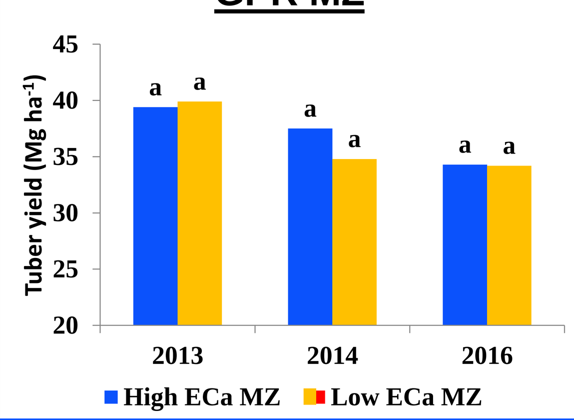
Δ3-yr – 6.8 Mg ha^{-1}

Dualem MZ



Δ3-yr - 7.4 Mg ha^{-1}

GPR MZ



GPR: No significant difference

Conclusions

- The Veris and Dualem were useful to delineate MZ, whereas the GPR was not.
- Higher soil ECa reflected increased clay and soil water content, but lower soil test P.
- Two MZs were identified, where the MZ with lower ECa had a higher yield potential.
- Lower potato yields in the high ECa MZ were attributed to excess water content from increased soil water holding capacity and poorer drainage.

References

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