Use of Proximal Soil Sensing to Delineate Management Zones in a Commercial Potato Field in Prince Edward Island, Canada

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Introduction

- Soil management zones (MZs) are areas with homogenous soil properties (Cambouris *et al.*, 2014).
- MZs allow for site-specific management of agricultural inputs to increase profitability of crop production, improve product quality, and protect the environment (Adamchuk *et al.*, 2004).
- Proximal soil sensors, which include geophysical instruments to map apparent soil electrical conductivity (EC_a), have been used to characterize the spatial variation of soil properties and to delineate MZs (Adamchuk *et al.*, 2015).

Objective

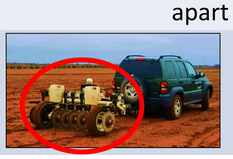
- To compare the efficiency of two proximal soil sensing systems for delineating MZs in a commercial potato field in Prince Edward Island, Canada.

Materials and methods

Experimental site and soil sampling design

- Springfield West, Prince Edward Island (PEI), Canada;
- 8.1-ha commercial field under potato (*Solanum tuberosum* L.) production;
- Triangular grid design : 30 m X 30 m spacing;
- 104 soil samples (0–0.15 m) : Mehlich-3 extractable P and K;
- 23 soil samples (0–0.15 m) : soil particle size.

Proximal soil sensing (PSS) systems

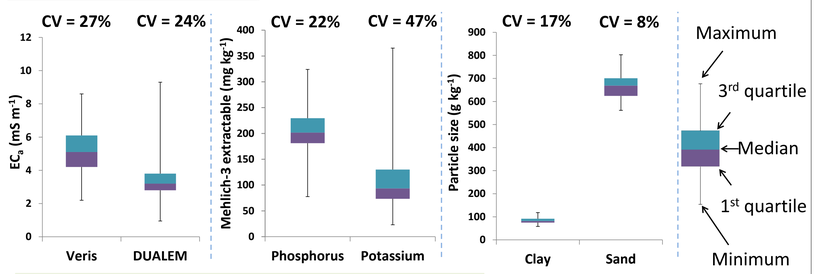
PSS systems	Veris 3100	DUALEM 21-S
Model	Veris Technologies Inc., model 3100, Salina, KS, USA	DUALEM. Inc., model 21-S, Milton, Ontario, Canada
Method	Galvanic contact resistivity	Electromagnetic induction
Selected depth of investigation	0-30 cm	0-40 cm
Data collection	Parallel transects spaced approximately 10 m apart at 1 Hz rate	
		

Statistical analysis

- Pearson correlation analysis: EC_a (Veris & DUALEM) and selected soil physicochemical properties;
- Total within-zone variance reduction: optimal number of MZs;
- ANOVA to validate the MZs.

Results & discussion

Descriptive statistics

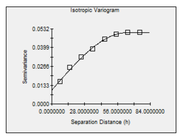


Moderate variations : 8% < CV < 47%

Geostatistical analysis

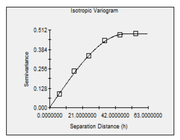
EC_a (Veris)

Model	Nugget ratio (%)	Spatial class	Range (m)	R^2_{vc}
Spherical	20	Strong	64	0.87



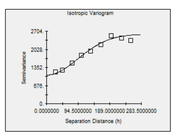
EC_a (DUALEM)

Model	Nugget ratio (%)	Spatial class	Range (m)	R^2_{vc}
Spherical	0	Strong	48	0.93



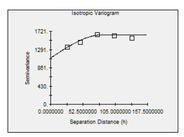
Soil test phosphorus

Model	Nugget ratio (%)	Spatial class	Range (m)	R^2_{vc}
Gaussian	41	Moderate	229	0.30



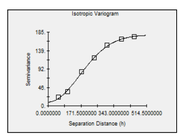
Soil test potassium

Model	Nugget ratio (%)	Spatial class	Range (m)	R^2_{vc}
Spherical	67	Moderate	85	0.22



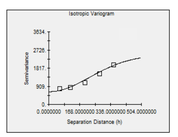
Clay

Model	Nugget ratio (%)	Spatial class	Range (m)	R^2_{vc}
Gaussian	0	Strong	393	0.28



Sand

Model	Nugget ratio (%)	Spatial class	Range (m)	R^2_{vc}
Spherical	2	Strong	331	0.34



Strong to moderate spatial structure (≤ 75%) for soil properties and EC_a measurements (Cambardella *et al.,* 1994)

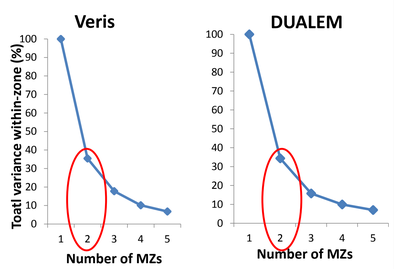
Pearson correlation analysis

	Veris	DUALEM
Veris	-	0.80 ***
DUALEM	0.80 ***	-
Soil test Phosphorus	0.22 *	0.20 *
Soil test Potassium	0.34 ***	0.33 ***
Clay	0.84 ***	0.74 ***
Sand	-0.83 ***	-0.63 ***

*, **, ***: significant at 0.05, 0.01 et 0.001 respectively

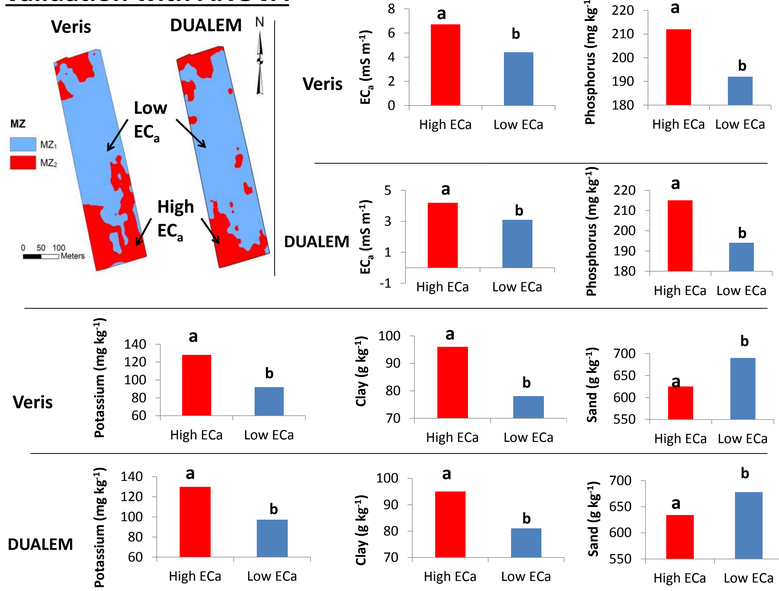
- Significant correlations between Veris and DUALEM;
- Significant correlations between EC_a and selected soil physicochemical properties

Optimum number of MZs



- Highest total within-zone variance reduction: 2 MZs
- 2 MZs → Veris → reduction of 65 %
- 2 MZs → DUALEM → reduction of 66 %

Delineation of MZs using fuzzy k-means algorithm and validation with ANOVA



- The two MZs delineated by the Veris and DUALEM showed significant differences for the soil EC_a, soil test P, soil test K, sand and clay content.
- High ECa management was associated with greater clay content and soil test P and K. An opposite pattern was observed for the areas with the lowest soil EC_a values.
- Low ECa MZ, with lower clay content, may be susceptible to water deficits and may require site-specific irrigation in MZ_1.
- The higher soil test P and K in MZ_1 may allow a reduction in fertilizer application of 45 kg P_2O_5 ha^{-1} and 40 kg K_2O ha^{-1}.

Conclusions

- The delineation of the study field into two MZs reduced a large part of the total variance.
- The Veris and DUALEM systems were both effective in delineating MZs.
- Site-specific nutrient and irrigation management could be implemented on this field.

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