Spatial variability of the effective depth to petrocalcic horizon using electrical resistivity in the sourthern Argentina pampas.

DOMENECH M[1], CASTRO FRANCO M[2], CICORE, P[3], COSTA JL[3], APARICIO V[3].
1. CEI INTA Barrow; 2. CONICET; 3. EEAI INTA Balcarce.

Introduction

Soil development in the plain landscape of the southeastern Buenos Aires Province is underlain by a discontinuous petrocalcic horizon, locally termed tosca. Detailed soil surveys in the region show complex and intricate patterns of soil types (*Amiotti et al., 2000***). Understanding the spatial distribution of soil depth to a restrictive layer, such as petrocalcic horizon is important for accurate soil map unit descriptions and delineations (***Boettinger et al., 1997***). Depth to root restricting layer affects both soil moisture and nutrient availability, resources strongly correlated to crop production.**

Traditional methods of quantifying mapping soil depth distribution can be tedious and costly. Clearly, efficient methods for accurately measuring are necessary to determine spatial variability of effective depth (ED) from a perspective of precision agriculture. Electrical resistivity has been used to nondestructively map selected soil properties.

The aim was to evaluate the effectiveness of zoning by electrical resistivity for assessing the distribution of soil depth to petrocalcic horizon in the southeast of Buenos Aires province.

Materials and Methods

The study site was a 32 hectares agricultural field, situated in Tres Arroyos Department. Soil Series in the study area were distinguished as Tres Arroyos (Petrocalcic Paleudoll**) and Semillero Buck (**Typic Argiudoll**) in the Cartographic Unit (CU) TA48 (Fig. 1). Apparent electrical conductivity (ECa) measurements were conducted at 0-30 cm and 0-90 cm depth with a 3100 Veris soil electrical resistivity sensor (Fig. 2). Effective Depth was determined with Giddings Soil Sampling equipment in a 30x30 m grid. Three zones of ECa were delimited (ZECa) and three composite samples from each zone were obtained. Gravimetric water content, clay content (As), pH and cation exchange capacity (CEC) were analyzed. Arc GIS 10.2 (***ESRI, 2010***) and SAS softwares were used to develop spatial analyst and correlation and simple regression analyst.**

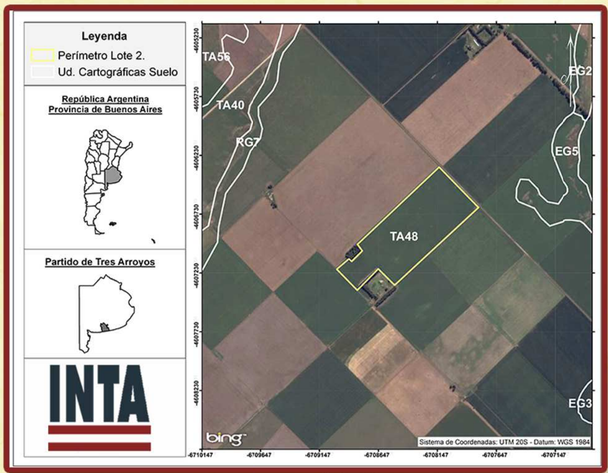

Fig 1. Experimental site and soil map unit..

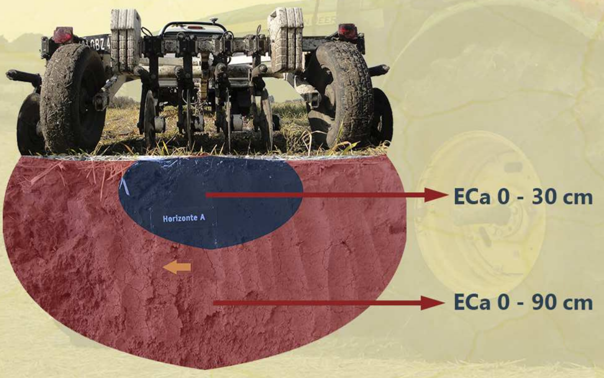

Fig 2. The Veris 3100 Soil Conductivity Mapping System employs two arrays to investigate soil al two depths, 0-30 and 0-90 centimeters.

Results and Discussion

ECa 0-30 cm showed positively strong correlation with ED (r=0.82). Shallow soil depth (<50 cm) exhibited similar As, CIC and pH. High ZECa could be spatially related with shallow soils identified within Tres Arroyos Serie. Middle and Low ZCEa could be associated with deeper soils related with Semillero Buck Serie. Because of greater porosity, unconsolidated materials have greater moisture content and therefore are more electrically conductive than consolidated materials. A decrease in depth of petrocalcic horizon is assumed to be more conductive because more soil water may be stored.

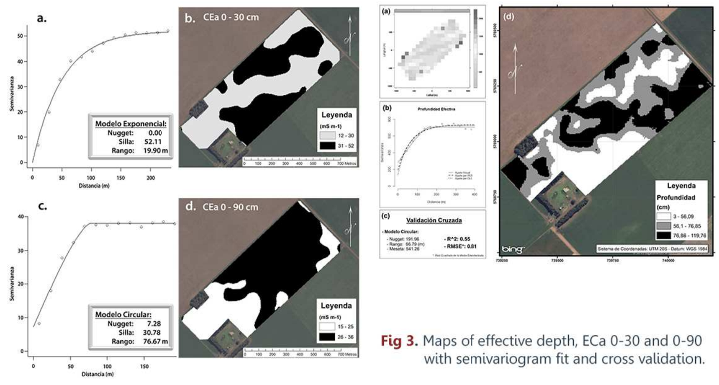

Fig 3. Maps of effective depth, ECa 0-30 and 0-90 with semivariogram fit and cross validation.

Table 1. Spatial regression model between ECa 0-30 and effective depth using spatial covariance.

Spatial Correlation[ǂ]	$PE = \beta_0 + \beta_1 (CEa\ 30) + \varepsilon$				**Spatial Covariance**[ȴ]		
	β_0	β_1	*F-value**	*Pr > F*	*Range (m)*	*Sill*	*Nugget*
Without	88,66	-0,87	88,66	<0,0001	220,00	350,00	30
With	68,32	-0,14	4,75	0,0300	65,94	320,67	5

ǂ. Spatial Correlation Model.
ȴ. Spatial covariance parameters
ƚ No aplicable (NA)

Table 2. Spatial regression model between ECa 0-90 and effective depth using spatial covariance.

Spatial Correlation[ǂ]	$PE = \beta_0 + \beta_1 (CEa\ 90) + \varepsilon$				**Spatial Covariance**[ȴ]		
	β_0	β_1	*F-value**	*Pr > F*	*Range (m)*	*Sill*	*Nugget*
Without	35,64	1,20	48,48	<0,0001	170,00	400,00	60
With	65,37	-0,04	0,35	0,5500	331,02	66,32	4,73

ǂ. Spatial Correlation Model.
ȴ. Spatial covariance parameters
ƚ No aplicable (NA)

Conclusion

The ECa measurements were particularly well suited for establishing within-field spatial variability of ED and contribute to study inherent soil properties. Although tosca layer has a great variability in depth, structure and CaCO3 content, the spatial measurements of ECa could be used as an indicator of soil properties

References

Amiotti, N., del C. Blanco, M., Sanchez, L.F., 2001. Complex pedogenesis related to differential aeolian sedimentation in microenvironments of the southern part of the semiarid region of Argentina. CATENA 43(2), 137-156.

Boettinger, J.L., Doolittle, J.A., West, N.E., Bork, E.W., Schupp, E.W., 1997. Nondestructive assessment of rangeland soil depth to petrocalcic horizon using electromagnetic induction. Arid Soil Research and Rehabilitation 11(4), 375-390.

Bork, E.W., West, N.E., Doolittle, J.A., Boettinger, J.L., 1998. Soil depth assessment of sage brush grazing treatments using electromagnetic induction. Journal of range management, 469-474.

Corwin, D.L., Lesch, S.M., 2005. Characterizing soil spatial variability with apparent soil electrical conductivity: I. Survey protocols. Computers and Electronics in Agriculture 46(1–3), 103-133.