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Electrical conductivity by induction and its correlation with soil factors and crop yield in southern Brazil

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Abstract

This work reports the experience done in a 19ha no-till field in Southern Brazil, aiming to correlate soil electrical conductivity (EC) measured by a induction sensor without contact and soil chemical fertility properties, soil texture, altitude, soil water content and crops yield before and after the measurement of EC.

Keywords: soil electrical conductivity, spatial variability, soil properties.

Introduction

The use of soil EC obtained by contact or induction sensors (Rhoades & Corwin, 1984) has been intensively used in some countries as a diagnostic technique for soil characteristics and their spatial variability. As EC is related to some physical and chemical properties of soil, it has potential on helping to define different management zones within a field (Domsch & Giebel, 2001). This is the first survey on induced soil EC in distroferric ferralsoils done in Southern Brazil between 2000 and 2002, aiming to correlate soil EC to soil and crops.

Material and methods

The experimental area is a 19ha no-till field. EC was obtained using an induction sensor without contact, based on a regular grid of 8.0 samples.ha^{-1} in the horizontal and vertical mode, corresponding to depths of 0.0 to 0.3m and 0.0 to 1.5m, respectively. At the same time soil texture and water content samples were collected at 0.0-0.2 and 0.2-0.4m depth on a regular grid of 2.0 samples.ha^{-1} in April 2001. Chemical fertility samples were collected at 2.8 samples.ha^{-1} and 0.0-0.1m depth, also on a regular grid, in late September 2001, before planting soybeans for the next season. Yield maps and altitude were obtained with yield monitor; corn was harvested in April 2001 and soybean in March 2002. A geostatistical analysis was performed defining the parameters for each component and kriging interpolations were done by using a dedicated GIS. A correlation matrix was generated from the surfaces, giving indication of tendencies and behavior of the different components values.

Results and discussion

The geostatistical analysis resulted in ranges above 150m and good cross validation, except for bases saturation (V%). The correlation matrix is shown on Table 1. Accentuated slopes and consequent soil erosion caused by intensive rains during the summer are characteristics of agricultural fields in Southern Brazil. No-till practices are being successfully used in the region for controlling it. The field presented slopes of up to 15% and it has been under no-till for 17 years, giving indications that before it intensive water erosion removed parts of the topsoil. The yield variability was intense on both, corn and soybeans, with correlation of 0.38, indicating that both crops are not well related in terms of spatial variability. Levels of EC at the 0.0 to 1.5m depth were significantly higher than at the 0.0 to 0.3m depth and the correlation between both was -0.28. Correlations with the major part of factors was opposite between both indicating that the soil profile changes significantly between the two layers where the sensor is measuring EC. As no other variable was monitored under 0.40m, the meaning of correlations between EC at 0.0 to 1.5m and those variables only has meaning if considered the effect of each variable on EC at its specific depth. Also, the correlation of clay and water content for EC between 0.0 to 0.3m depth was around 0.40, except for clay at 0.0-0.2m where it was only 0.26. Other indications were CEC and sum of bases (SB), giving positive correlations of 0.26 and 0.24, respectively, for EC at 0.0 to 0.3m. Strong and expected positive correlations were observed between clay and water content and also between clay and organic matter and negative between clay and pH. The sensor presented difficulties on operation, related to frequent necessary calibrations, being affected by local temperature changes. An additional survey on EC based on direct flow measurement could provide answers on the variabilities and increase the operational accuracy. One concern of using EC information on local soils is the iron content that may affect the results on indicating soil characteristics for field variability understanding and it will require more investigation.

Table 1. Correlation matrix generated from the surfaces of 10m cells, giving indication of tendencies and behavior of the different variables.

Variables	Soy.	Corn	CEC	V%	SB	OM	pH	Alt.	Moist.	Sand	Clay	Moist.	Sand	Clay	EC
			Depth 0.0-0.1m						Depth 0.2-0.4m			Depth 0.0-0.2m			0.0-0.3m
EC 0.0 -1.5m	0.19	-0.01	-0.19	0.40	-0.02	-0.3	0.36	0.19	-0.32	0.27	-0.36	-0.35	0.30	-0.30	-0.28
EC 0.0 - 0.3m	0.03	0.13	0.26	-0.11	0.24	0.22	-0.21	-0.45	0.40	-0.32	0.41	0.41	-0.30	0.26	
Clay 0.0 - 0.2m	-0.34	0.10	0.88	-0.56	0.67	0.94	-0.86	-0.17	0.95	-0.94	0.88	0.97	-0.99		
Sand 0.0 - 0.2m	0.36	-0.08	-0.86	0.54	-0.66	-0.93	0.85	0.18	-0.96	0.95	-0.87	-0.98			
Moist. 0.0 - 0.2m	-0.29	0.14	0.85	-0.52	0.66	0.90	-0.83	-0.21	0.97	-0.93	0.90				
Clay 0.2 - 0.4m	-0.20	0.20	0.79	-0.46	0.62	0.81	-0.74	-0.24	0.87	-0.76					
Sand 0.2 - 0.4m	0.32	-0.08	-0.79	0.51	-0.60	-0.87	0.80	0.17	-0.96						
Moist 0.2 - 0.4m	-0.26	0.16	0.82	-0.53	0.63	0.89	-0.83	-0.18							
Altitude	0.11	0.00	-0.23	-0.09	-0.25	-0.22	-0.05								
pH	0.30	-0.03	-0.72	0.84	-0.38	-0.86									
OM	-0.33	0.10	0.91	-0.56	0.69										
SB	-0.03	0.17	0.91	0.12											
V%	0.34	0.06	-0.31												
CEC	-0.18	0.15													
Corn	0.38														

Conclusions

Correlation analysis of EC with soil chemical fertility properties, soil texture, altitude, soil water content and crops yield resulted in important indications of sources of variability suggesting that EC may be a good measure on rapid soil diagnostic under this conditions.

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