Spatial relationship between soil electrical conductivity and soybean grain quality in the Argentinean Pampas

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Introduction

Argentina is the first exporter of soybean meal and oil (MAGyP, 2012)**. Information about the effect of spatial variability of soil and environment on grain quality of soybean is highly demanded. However, most of the research was focused on increasing the production of grain per unit area. Analysis of soybean variety trials has revealed large regional scale trends in soybean seed protein and oil concentrations, mainly due to maturity group** (Martin et al., 2007; Piper and Boote, 1999)**. In Argentina, less attention has been given to investigate the relative importance of soil parameters that determine soybean protein and oil concentrations variability within field.**

Temporal and spatial variability of soil factors contributes to crop performance variability (Zheng et al., 2009)**.** Martin et al. (2007) **found significant associations between spatial variability soil characteristics and soybean plant performance at field scale. from the association between spatial patterns and grain protein and oil concentration is possible to delimit areas of harvest woth different grain quality.**

The geospatial measurement Apparent soil electrical conductivity (ECa) is an efficient technology that is helping to bring precision agriculture from concept to a reality (Corwin and Lesch, 2003)**. ECa can be intensively recorded, in an easy and inexpensive way and it is usually related to various soil properties. We hypothesize that the ECa in combination with spatial analysis of soybean crop properties, can be used to understand the variability of protein and oil contents in soybean grains within a field.**

The objective was to characterize the spatially relationship between soybean grain composition and soil properties.

Materials and Methods

ECa data were collected with a coulter-based sensor (Veris EC 3100) **(Fig. 1) on two fields of the Argentinean Pampas** (Mercapire: Lat: 33.522 N, Lon: -62.910 W; San Esteban: Lat: 33.524 N, Long: 62.763 W) **(Fig. 2). In both fields, the soils are excessively drained with high sand content and their use is limited by low moisture retention and rainfall.**

Two zones of ECa were delimited (ZECa) **and three composite samples from each zone were obtained. Soil samples were taken at 30 and 90 cm deep in 8-16 sampling sites to determine soil properties. Soil organic matter** (OM) **Clay content** (As)**, pH and cation exchange capacity** (CEC) **were analyzed. Plant samples were obtained from the same sampling sites to determine biomass, grain number and weight, and grain quality. Arc GIS 10.2** (*ESRI, 2010*) **and SAS softwares were used to develop spatial analyst and correlation and simple regression analyst.**

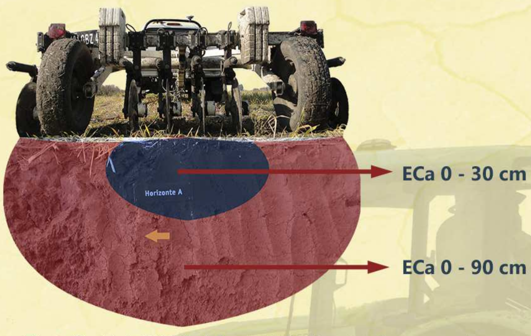

Fig 1. The Veris 3100 Soil Conductivity Mapping System employs two arrays to investigate soil al two depths, 0-30 and 0-90 centimeters.

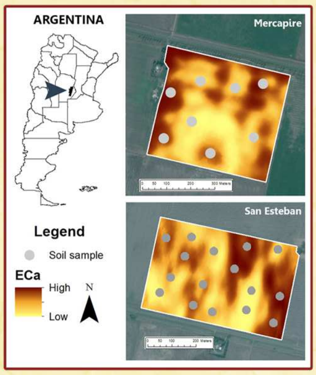

Fig 2. Classified ECa map and sampling scheme for both experimental fields.

Table 1. Correlation matrix for soil atributes. 0 to 30 cm depth for both experimental fields

	ECa 0 - 30 cm	ECa 0 - 90 cm	Biomass	Seed / m2	Seed weight / m2	Seed protein	Seed oil	Soil OM†	Soluble salts
ECa 0 - 30 cm	1								
ECa 0 - 90 cm	0.87*	1							
Biomass	0.76*	0.91*	1						
Seed / m2	0.37	0.66*	0.60*	1					
Seed weight / m2	0.40	0.70*	0.65*	0.69*	1				
Seed protein	-0.14	-0.53*	-0.57*	-0.73*	-0.75*	1			
Seed oil	0.04	0.12	-0.09	0.34	0.34	-0.03	1		
Soil OM†	0.43	0.66*	0.58*	0.73*	0.77*	-0.52*	0.39	1	
Soluble salts	0.69*	0.71*	0.52*	0.53*	0.54*	-0.15	0.15	0.68*	1

*. Significant at the 0.05 level

†. OM: Organic Matter;

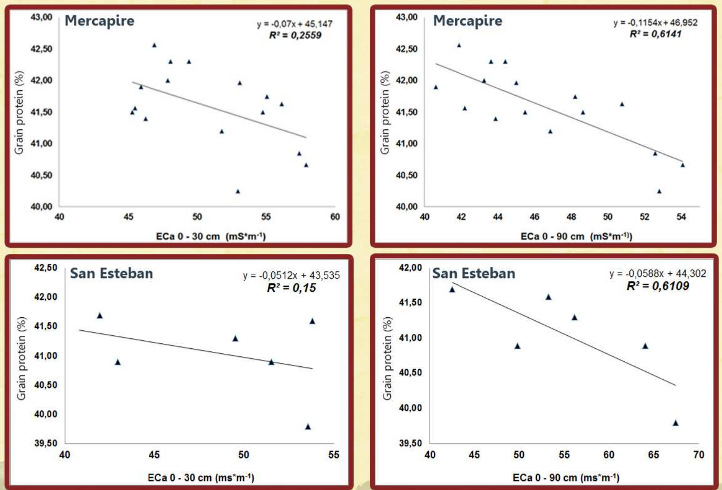

Fig 3. Relationship between ECa and Seed protein concentration for both experimental sites

Results and Discussion

Correlations of ECa with soil organic matter contents (MO) **were generally highest and most persistent across two fields and ECa data types (Table 1). Crop properties** (Biomass, grain number and weight) **were strongly related to ECa in both fields. Regressions estimating soil fine fraction and MO as a function of ECa 0 - 90cm across two study fields were reasonably accurate** (r^2>0.6)**. Areas of high ECa generally had higher content of clay, loam and MO.**

The regression analysis showed association between ECa and grain quality. The ECa 0 - 90cm explained soybean protein concentration more consistently than ECa 0 - 30cm (Fig. 3). In general, areas of higher ECa 0 - 90cm had higher grain oil concentration. Zones with higher content of clay, loam and MO had higher biomass and grain number and weight.

Conclusion

Spatial variability soil properties affected soybean protein and oil concentrations. Zones with higher ECa 0 – 90cm have a higher OM, biomass and grain number and weight. Particularly, the results of regression analysis between protein concentration and ECa 0 – 90 cm was similar for both experimental fields. These relationships suggest that spatial variability of ECa can be an indicator of the spatial distribution of soybeans protein and oil concentration.

References

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