Mineral content and its environmental effect of soybeans (Glycine max (L.) Merril) cultivated in Argentina

Carla G. Marioli Nobile[1], Mónica Balzarini[2], Fernando Aguate[2], Rafael Suárez[1], Daniel Ploper[1] and María Jose Martínez[3]

[1]EEAOC, CP T4101XAC, Las Talitas, Tucumán, Argentina; [2]FCA – UNC, Cátedra de Estadística; [3]INTA – EEA Manfredi, Laboratorio Calidad Nutricional de Granos

Introduction

- Minerals affect the quality and safe of soybean end products.
- Argentina is the third soybean exporter worldwide and, the soybean-production area embraces a wide range of environments.
- The aim of this study was to investigate the effect of location and environment on the mineral content of soybeans cultivated along the Argentine soybean cropland.

Materials and Methods

- Soybeans: ALIM3.14 (non-GMO, food-type high-protein) and CS (commercial GMO soybean, widely used in Arg).
- Field study: 20 environments were defined as the combination of location, sowing date, and crop year (Table1 and Fig.5). Cultural practices followed the same protocol in all the locations according to the multi-environment trial network.
- Climatic variables were recorded during the seed filling period of the soybean crop (R5R7) (Table 1) (Carrera et al., 2011).
- Routine soil analysis and, macro and micronutrients analysis were performed in the soil samples.
- Mineral contents in soybeans were determined by ICP-MS.
- Descriptive statistics and Partial Least Squares (PLS) regressions were performed with Infostat software (DiRienzo et al., 2011).

Table 1. Climatic variables and soil properties of the locations.

Location	Soil Texture	pH (*)	OM (***) %	CEC Cmol/kg	Year	Sowing date	Tmx °C	T °C	Tmn °C	Sr MJ/m²	pp-pEVT mm
BW	Loam	6.4	2.3	21.5	2006	Early	25.0	18.4	11.9	19.69	60.3
						Late	23.6	17.6	11.5	17.27	-17.9
BO	Sandy Loam	6.8	1.4	14.9	2006	Early	25.0	18.4	11.9	18.26	66.7
					2007	Late	25.0	17.8	10.6	15.67	-28.6
CE	Loam	6.2	1.1	10.4	2006	Early	26.0	21.4	16.8	16.15	24.2
						Late	24.3	20.2	16.0	13.43	5.5
					2007	Early	24.7	19.5	16.0	13.28	199.7
						Late	24.5	19.4	16.2	14.50	47.6
CA	Loam Clay	5.7	2.4	28.7	2006	Early	30.2	25.1	19.9	22.70	92.2
						Late	30.1	25.1	20.1	20.76	91.3
					2007	Late	29.7	24.6	19.5	20.13	47.5
FA	Loam Clay	6	1.9	11.3	2006	Late	26.8	22.0	17.2	11.53	6.4
					2007	Early	29.7	24.3	19.0	16.95	158.2
						Late	27.6	22.8	18.0	13.52	253.3
MA	Loam Silt	6.9	2	19.7	2006	Early	27.0	22.0	16.8	20.98	-27.7
						Late	25.6	20.8	16.0	16.14	79.0
					2007	Early	27.4	22.1	16.7	19.24	8.3
						Late	25.6	19.5	13.4	15.25	30.3
PA	Loam Clay	6.2	3.2	30.8	2006	Early	26.9	22.2	17.5	16.64	337.1
						Late	25.1	21.0	16.9	13.40	401.7
					2007	Late	27.3	21.1	14.9	17.61	-63.0
RQ	Loam Clay	6.2	1.5	15.5	2006	Early	30.1	25.0	19.9	20.39	201.3
						Late	28.6	23.9	19.2	17.35	-15.7

(*) 1:2.5, (***) Walkley-Black

Results

Figures 1. 2. 3. Mineral elements in soybeans grown along the Argentine soybean cropland.

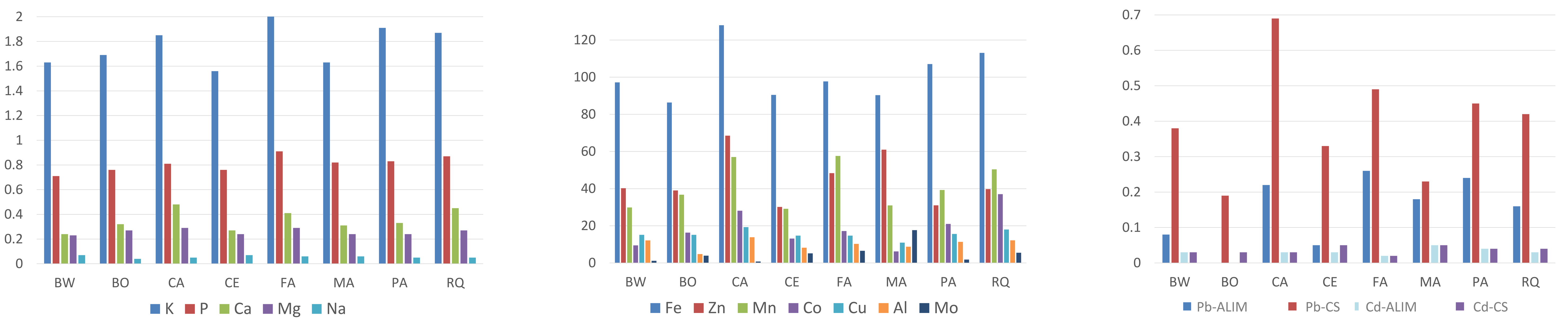
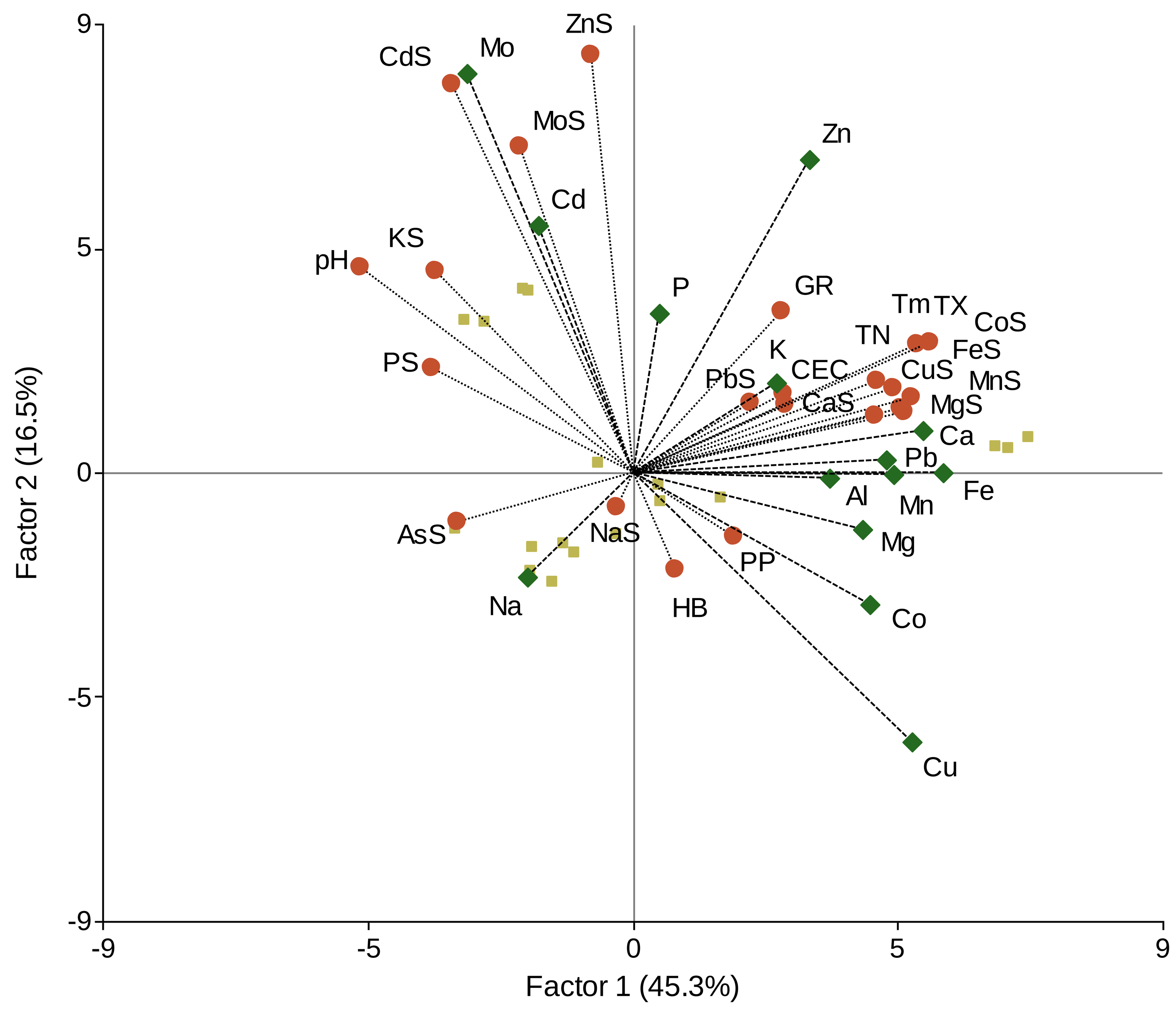


Figure 1 and 2. Main values of macronutrients K, P, Ca, Mg, Na (g/100g DB) and micronutrients Fe, Zn, Mn, Cu, Al, Mo (mg/kg), Co (ug/100g) averaged between genotypes.

Figure 3. Minor elements Pb and Cd (mg/kg) in ALIM3.14 and CS.

Statistical significant differences were observed for mineral elements in soybeans grown in different locations (Fig. 1, 2, 3). Although location had the biggest impact on mineral composition, soybean type (CS vs ALIM) showed significant effect on minor elements (Fig. 3).

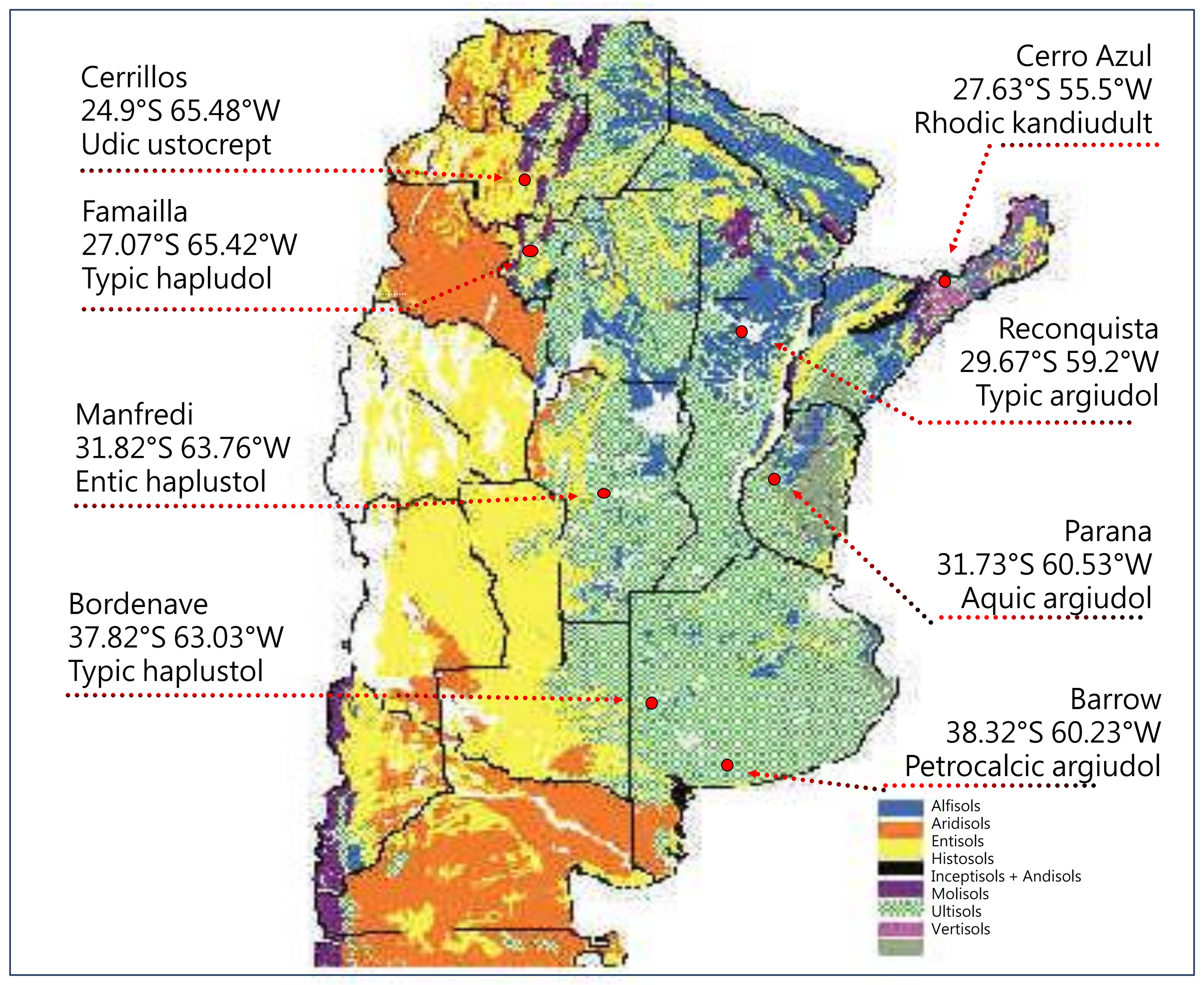
Figure 4. PLS-triplot of minerals in soybeans with environment and soil co-variables.



Climatic and soil minerals co-variables (●): Tm (mean daily air temperature, ºC); TX (mean daily maximum air temperature, ºC); TN (mean daily minimum air temperature, ºC); PP (precipitation, mm); HB (hydric balance, mm) (HB=PP-PET); GR (global radiation) CEC (cation exchange capacity, Cmolc/kg); PS (soil available Phosphorous, mg/kg); pH; NaS, KS, CaS and MgS (cations in soil, Cmolc/kg); MoS, MnS, FeS, ZnS, CdS, PbS, CuS, CoS (micronutrients and trace elements in soil, mg/kg). Minerals in soybeans (◆): Ca, Mg, K, P and Na (g/100g DB soybeans); Fe, Zn, Al, Mn, Mo, Co, Cu, Cd and Pb (mg/kg DB soybeans). Environments (■).

Temperature was the main environmental co-variable affecting both mineral composition of soybeans and mineral and chemical properties of soils. Cd, Mo, Zn and Ca in seeds showed a strong correlation with their presence in soil (Fig.4).

Figure 5. Soil map of Argentina showing the geo-position of the studied locations and their soil taxonomy along the soybean cropland (1:500000).



Adapted from: http://geointa.inta.gov.ar/visor/?p=model_suelos

Conclusions

Mineral content of soybeans was highly influenced by location. Different patterns on seed-mineral accumulation were also observed between the two soybean types (ALIM and CS). Location was the main factor affecting the mineral composition of the soybeans. Soybeans are actually being used in different products. Therefore, location should be considered when addition of value is pursued.

Acknowledgements

Project funded by PNOLE031041 & PNAIyAV1130043 INTA (Instituto Nacional Tecnología Agropecuaria). PhD scholarship of Marioli Nobile granted by CONICET (Centro Nacional de Investigaciones Científicas y Tecnológicas). Technical support and facilities at EEAOC (Estación Experimental Agroindustrial Obispo Colombres).

CONICET 400 AÑOS UNC | Universidad Nacional de Córdoba EEAOC INTA