SUPPLEMENTARY DATA
Mezzatesta, D. S., Berli, F. J., Arancibia, C., Buscema, F. G., & Piccoli, P. N. (2022).
Impact of contrasting soils in a high-altitude vineyard of *Vitis vinifera* L. cv. Malbec: root morphology and distribution, vegetative and reproductive expressions, and berry skin phenolics. *OENO One*, *56*(2). https://doi.org/10.20870/oeno-one.2022.56.2.4917

Supplementary Material

Site selection and soil analyses:

The vineyard soil was characterised by overlapping the following spatial maps (Figure 1S): soil electrical conductivity (EC) at depths of 0.5 m and 1.5 m, normalised difference vegetation index (NDVI) mapped in December 2014 (AgroPraxes SA, MZA, Argentina) and soil effective depth map (70 holes per ha) created by ArcGIS 10.2.2 (Esri Inc. CA, USA); geolocation was conducted using a GPS Garmin ETREX 30 (Garmin International, Inc., KS, USA). The experimental plots (0.15 ha each) were selected in two areas where the maps showed contrasting soil situations, with homogeneous irrigation and vine trunk diameter within the plots. Levels of soil factor were named shallow soil (SS; depths of 0- 0.45 m) and deep soil (DS; depths of 1-1.5 m), according to the classes of root-restricting depth proposed by NCRS Soils (usda.gov). A full description of their profiles is presented in Table 1S. Particle-size distribution was performed by the hydrometer method and texture was determined according to the International System of the Soil Science Society classification (Gee and Or, 2002). From representative samples of both soil type profiles, stone content (%) was determined based on a known volume of water displaced by the coarse texture (> 2 mm). In 2017 and 2018, a week before harvest, three soil composite samples (made up of three sub-samples) per soil type were obtained at depths of 0.3 and 0.6 m, 0.3 m away from the vine trunks. The < 2 mm fraction was used for soil analysis according to the following methods (Sparks *et al*., 1996): total nitrogen (Kjeldahl method), calcium carbonate (volumetric calcimeter method), pH in the saturated soil paste, electrical conductivity (EC) using 1:2 or 1:5 soil extract: water ratio when the EC of the saturation extract was 0.5-1 dS/m_{-1} or 1-2 dS/m_{-1} respectively (Saturation extract procedure, dS/m_{-1} at 25 °C), exchangeable K (Ammonium acetate method) and organic matter (Walkley-Black method). Available P was assessed by carbonic extraction 1:10 (Breazeale and McGeorge, 1932). Available Water Content (AWC) was affected by the rooting capacity of each soil layer, as proposed by Costantini (2021) with potential AWC calculated through the U.S. Natural Resources Conservation Service model (NCRS, 2013) and bulk density values from Chambouleyron (2005) and Daddow (1983) in accordance with field observations. Cloddiness estimations were based on Ball *et al*. (2007) and Costantini (2021). Physico-chemical descriptions of the soils are presented in Table 2S.

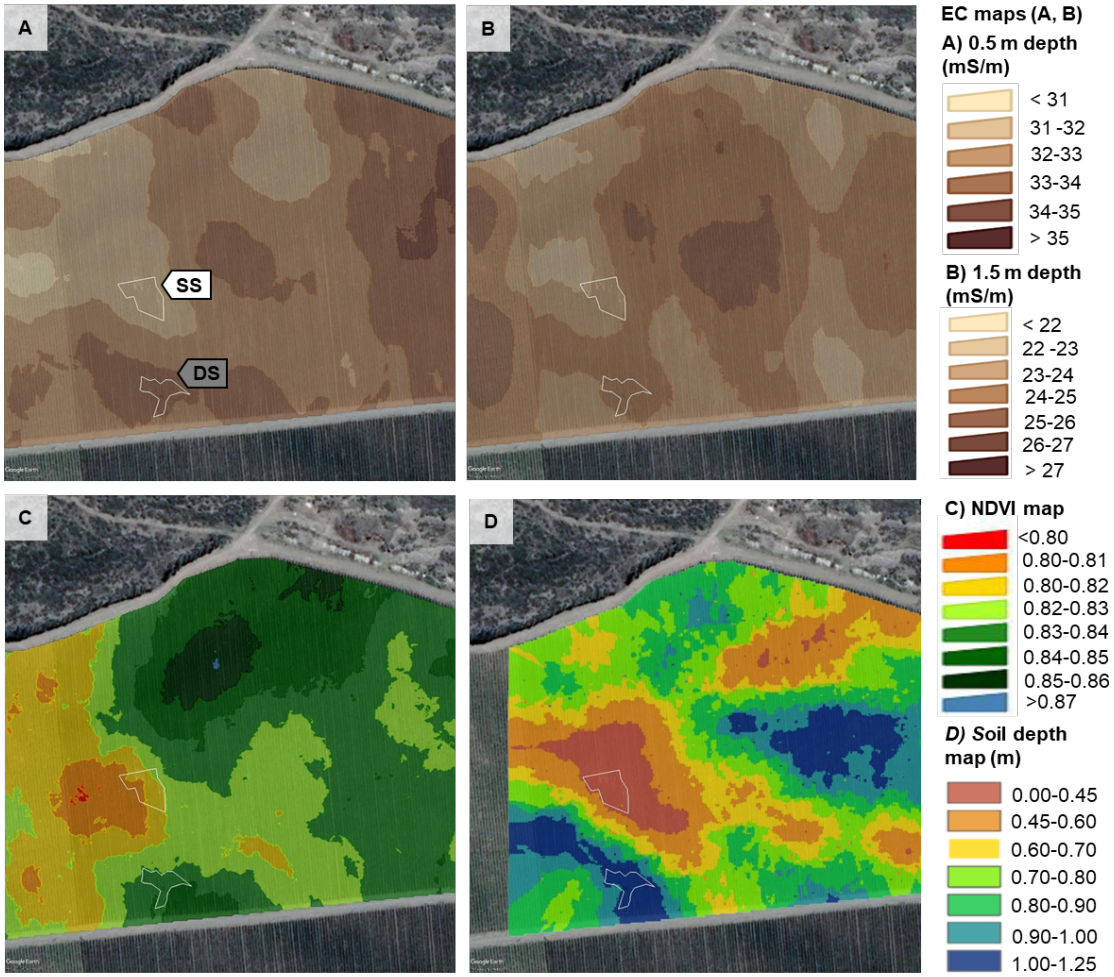


Figure 1S. Maps used to select the experimental plots within the vineyard. Soil electrical conductivity (EC) at depths of 0.5 m (A) and 1.5 m (B). *Normalized difference vegetation index (NDVI; C) and soil effective depth map made from 70 holes per ha (D).* SS: shallow soil and DS: deep soil selected after maps superposition.

Table 1S. Shallow soil profile description according to the standards proposed in Schoeneberger *et al*., 2012.

General description of the sites	
Taxonomic classification	Tipic Torriorthent
Parent Material	Sandy silty sediments conglomerate deposits of igneous, metamorphic and sedimentary rocks covered by calcium carbonate.
Landscape	Alluvial fan
Landform	Top slope
Drainage Class	Well
Flooding	No flooding
Ponding	No ponding
Bedrock	None present
Shallow soil (SS)	
Coordinates	33;23;40.74 S; 69;15;13.839 O
Altitude	1351.71 m

Soil profile	**Ap** - - 0 to 14 cm; grayish brown (2.5 Y 5/2) dry; dark brown (10 YR 3/3) moist; sandy; massive structure; loose consistency; few roots; pH alkaline; gradual wavy boundary. **Akm** - - 14 to 22 cm; pinkish gray (7.5 YR 7/2) dry; light brown (7.5 YR 6/4) moist; sandy; coarse granular structure; very hard consistence; many very coarse and very fine roots; very alkaline, gradual wavy boundary. **2Ck1**- - 22 to 53 cm; white (10 YR 8/1) dry; brown (10 YR 5/3) moist; extremely gravelly cobbly fine sand; massive structure; loose consistency; 75 percent of 2–15-centimeter unspecified fragments; many fine and very fine roots; very alkaline, gradual wavy boundary. **2Ckm2** - - 53 to 75 cm; white (10 YR 8/1) dry; yellowish brown (10 YR 5/4) moist; extremely gravelly cobbly sand; massive structure; very hard consistence; 80 percent of 2–15-centimeter unspecified fragments; many fine and very fine roots; very alkaline, gradual wavy boundary. **2Ckm3** - - 75 to 82 cm; white (10 YR 8/1) dry; yellowish brown (10 YR 5/4) moist; extremely gravelly cobbly coarse sand; massive structure; very hard consistence; 80 percent of 2–15-centimeter unspecified fragments; many coarse and fine roots; very alkaline, gradual wavy boundary. **2Ck4** - - 82 to 135 cm; (10 YR 7/2) dry, yellowish brown (10 YR 5/4) moist; extremely gravelly cobbly coarse sand; massive structure; loose consistency; 75 percent of 2–15-centimeter unspecified fragments; many fine roots; pH alkaline, gradual wavy boundary.
	Deep soil (DS)
Coordinates	33;23;43.369 S; 69;15;12.959 O
Altitude	1350.08 m
Soil profile	**Ap** - - 0 to 20 cm; grayish brown (2.5 Y 5/2) dry; dark brown (10 YR 3/3) moist; sandy; massive structure; common very fine and fine roots; loose consistency; pH alkaline; clear smooth boundary. **Ab** - - 20 to 54 cm; grayish brown (2.5 Y 5/2) dry; dark brown (10 YR 3/3) moist; sandy; very coarse masses dark brown (10 YR 2/2) moist; massive structure; slightly hard consistence; common very fine and fine roots; loose consistency; pH alkaline; clear smooth boundary. **Ck** - - 54 to 135 cm; grayish brown (2.5 Y 5/2) dry; dark brown (10 YR 3/3) moist; fine sand; massive structure; loose consistency; common coarse and medium roots; few very coarse roots; pH alkaline; clear smooth boundary.

Table 2S. Shallow (SS) and deep soils (DS) physico-chemical characteristics. Values are means ± SEM. Asterisks in a row represent significance at $P < 0.05$ (LSD Fisher).

Soil parameters	SS	DS
Soil depth (cm)	33.25 ± 6.17 *	116.25 ± 3.7
Stones content (%)	77.00	0.00
AWC (mm)	12.6	50.6
Clay (<0.002 mm)	4.33 ± 0.33	2.67 ± 0.33
Lime (0.002-0.02 mm)	4.17 ± 0.45	3.33 ± 0.45
Sand (0.02-2 mm)	91.50 ± 0.40 *	94.00 ± 0.4(
Texture (international)	sandy	sandy
pH	7.26 ± 0.03*	7.38 ± 0.03
Electrical conductivity ($dS.m^{-1}$)	1.09 ± 0.08	1.25 ± 0.08
Total nitrogen (mg/kg^{-1})	640.50 ± 26.37*	539.75 ± 26.:

Organic matter (%)	0.99 ± 0.04*	0.80 ± 0.04
Available P (mg/kg^{-1})	4.76 ± 0.62	5.92 ± 0.62
Exchangeable K (mg/kg^{-1})	181.48 ± 14.74	183.70 ± 14.′
Calcium carbonate content (%)	1.84 ± 0.19*	0.23 ± 0.19

(*) Statistic differences ($p < 0.05$)

Table 3S. Average maximum (T max), mean (T mean) and minimum (T min) air temperatures and accumulated rainfall in the vineyard. Values are means ± SEM from September to March.

Season	T max (°C)	T mean (°C)	T min (°C)	Accumulated rainfall (mm)
2016	21.42 ± 0.45	15.21 ± 0.38	9.30 ± 0.35	775.5
2017	24.07 ± 0.42	16.80 ± 0.35	9.33 ± 0.31	289.5
2018	23.97 ± 0.39	16.39 ± 0.35	8.79 ± 0.35	189.5

Table 4S. Dates of harvest with brix levels and pH of musts of Malbec grapes from SS and DS soils in 2016, 2017 and 2018 vintages.

Year	Soil	Harvest dates	Brix level	pH
2016	SS	April, 6 th	22.3	3.28
	DS	April, 15 th	22.0	3.39
2017	SS	March,14 th	24.9	3.39
	DS	March, 28 th	24.1	3.59
2018	SS	March, 9 th	24.2	3.16
	DS	March, 21 th	23.7	3.31

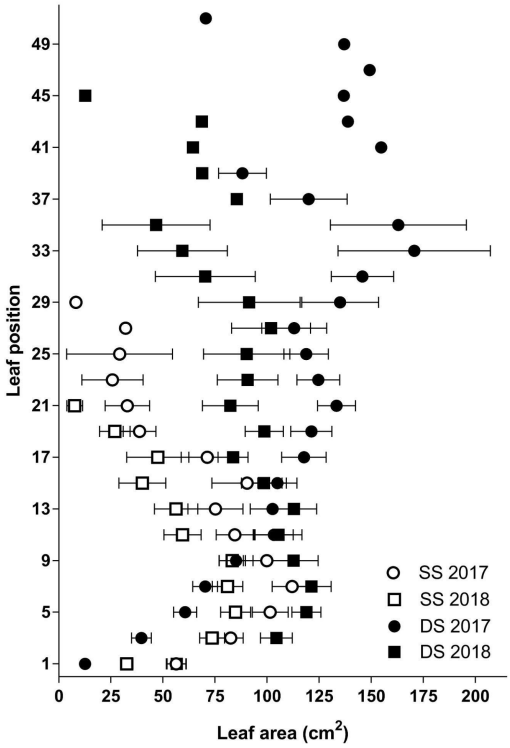


Figure 2S. Canopy architecture represented by leaf area measurements along odd leaves per shoot for SS and DS vines measured at verasion of 2017 and 2018 seasons (n = 24).

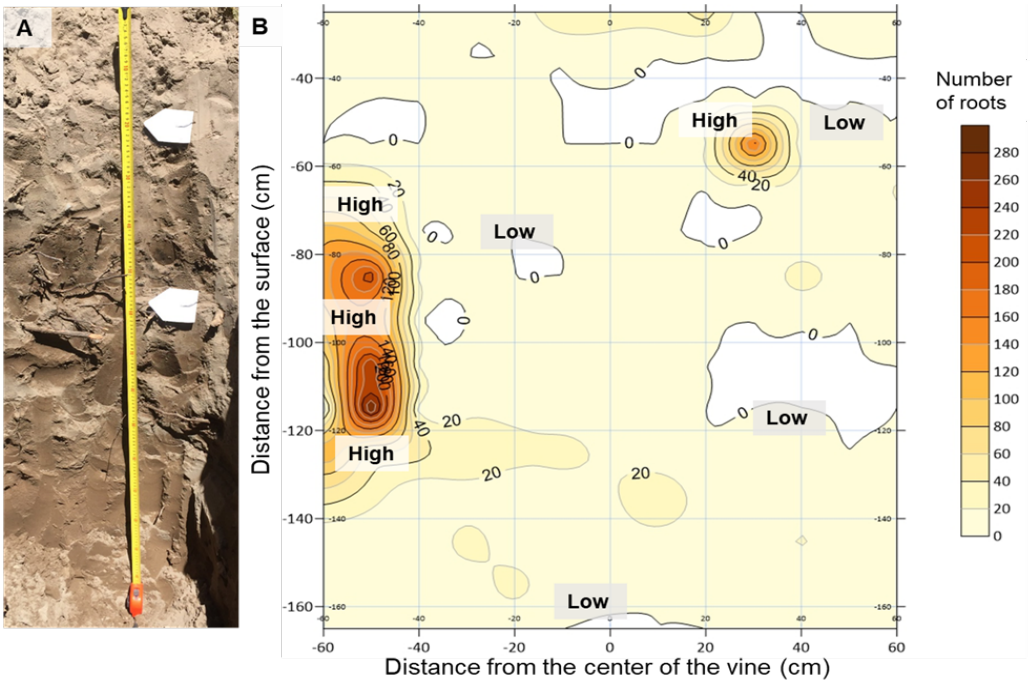


Figure 3S. A. Deep soil profile. B. Root density distribution of fine roots (< 1 mm) determined by Bohm method (1979) in autumn-winter 2019. Labels of High and Low correspond to patches of high- and low-fine root density categories.

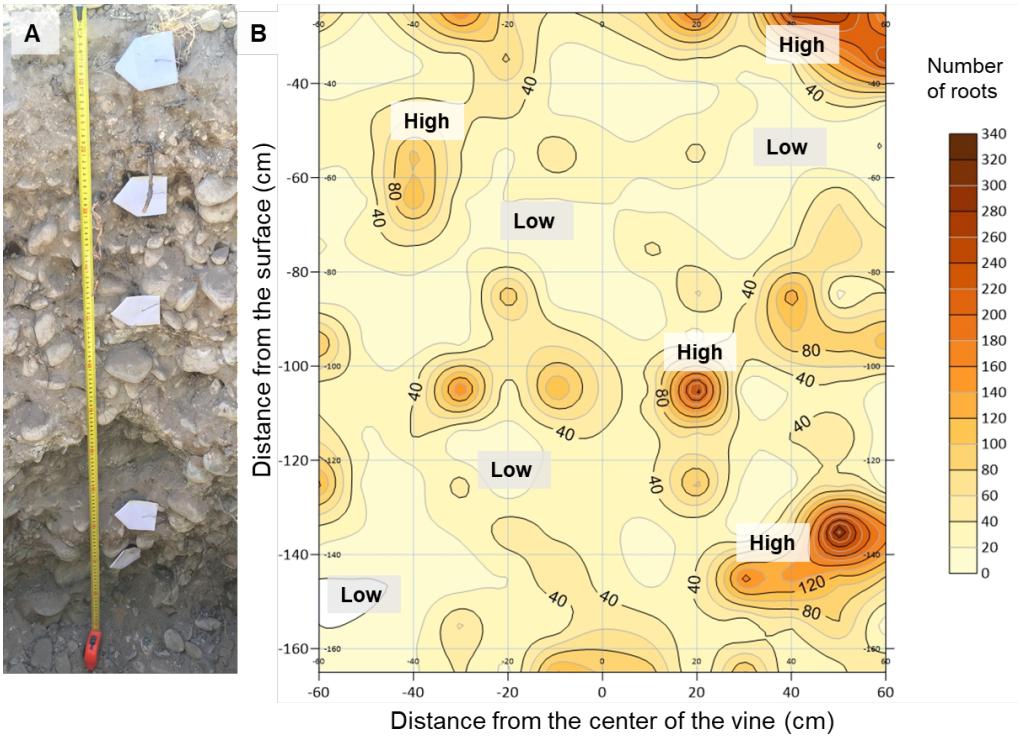


Figure 4S. A. Shallow soil profile. B. Root distribution of fine roots (< 1 mm) determined by Bohm method (1979) in autumn-winter 2019. Labels of High and Low correspond to patches of high- and low-fine root density categories.