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THE IMPACT OF SOIL PROPERTIES ON LEACHATE CHARACTERISTICS AND AVOCADO SEEDLINGS GROWTH

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Abstract: It was established that local soil texture was characterized as silt and handmade substrate as silt loam. It was established that the share of sand fraction in local soil is less than 2 times compared to the handmade substrate. Leachate pH and EC of local soil were a little bit higher than in handmade substrate. It was established that the leaves square of avocado plants growing in silt loam substrate is more than 15 % compared to silt local soil. Obviously, the best opportunities for infiltration of irrigated water are the leading factor in ensuring the development of the Avocado plant.
Keywords: soil, texture, leachate, leaf square, avocado

INTRODUCTION

Avocado cultivation amounted to 12,832 ha, and most of this area is located in SE Spain (Andalucía) with 10594 ha (83%), followed by the Canary Islands (13%) and Valencia (9%) provinces (*OPM–CAGPDS, 2022*). The Mediterranean climate is characterized by scarce and irregular rainfall. The average annual rainfall in some areas in SE Spain varies between 500 and 300 mm per year (*Gonzalez–Hidalgo et al., 2003*).

Andalusia avocado production represents 82% of the national total (*Rodríguez et al., 2009*). Due to the elevated prices of the avocado fruit, many farmers invest in planting avocados in hill slope areas on terrace orchards and establishing irrigation systems (*Durán et al., 2013*). Current avocado productionhas a significant impact on water access for local communities and generate water stress (*Sommaruga and May, 2021*). Thus, transfer from management practices that degrade soil quality to organic system is necessary since water quality deterioration is considerably lower than in conventional agriculture. It is necessary to redesign irrigation strategies in Mediterranean areas, focusing on the benefits of sustained–deficit irrigation, which can save water, encourage water use efficiency and enhance fruit quality (*Durán et al., 2021*).

Avocado is usually grown in arable lands having saline irrigation water (an EC greater than 0.75 dS/m (Crowley, 2008).The dramatic differences were in the amount of leaf damage among rootstocks after 23 months of irrigation with water having an EC of 1.5 $dS \cdot m^{-1}$ (*Celis et al., 2018*). Salinity had a significant influence on the growth pattern of the avocado seedlings, affects photosynthesis by stomatal limitations and led to salt accumulation in young leaves (*Lazof and Bernstein, 1997; Parida and Das, 2005; Munns and Tester, 2008*).

Different growth reductions and leaf necrosis were indicated among avocado cultivars under salt stress (*Mickelbart and Arpaia, 2002*). Salinity affects photosynthesis by stomatal limitations, led to salt accumulation in young leaves and considerable decrease in the weights of leaves, stems, tillers and roots of susceptible (*Parida and Das, 2005; Munns and Tester, 2008; Berkessa, 2020*). Salinity problems are more difficult to solve in clay soils (*Crowley, 2008*). High clay soils that have poor drainage are particularly problematic in that salts are not easily leached.

The main objective of our case study was to estimate the impact of soil properties on leachate characteristics and avocado seedlings growth.

MATERIALS AND METHODS

The subtropical climatic conditions required for the development of the avocado tree in Malaga province. The climate of this region is characterized by temperate average temperatures (~20 C throughout the year) with high environmental humidity. The region is a narrow strip about 12 km wide parallel to the Mediterranean coast that has a special

microclimate due to the arrangement of the intertropical valleys, which have a north–south orientation and are protected against northerly winds by the Penibetic mountain range, which runs towards the edge of the coast from east to west.

The achievement of the exposed objectives were carried out in the facilities of the "La Mayora Experimental Field site", of the Higher Council for Scientific Research (CSIC), which is therefore representative of the agricultural holdings of the environment, and which has the same problem. The pot experiment with avocado was monitored last three months. The soil texture and particles size were determined with "Mastersizer" (Figure1).

Figure 1 – Soil texture measurement

The preliminary made avocado leaf square calibration method was developed to avoid necessity to cut leaves in pot experiment. A leaf print was obtained using Xerox. Then the contour of the print was outlined. Having received in one way or another imprint of the sheet, determined its area. The area of the sheet under study was found by the formula:

$$S_x = \frac{a \cdot c}{b}, [cm^2] \quad (1)$$

where: a – the mass of the leaf contour, mg;
b – the mass of a square of paper, mg;
c – the area of a square of paper, cm².

Next step required from us just to measure two leaf size indexes – length (L) and width (W) to know ratio coefficient (RC) between S_x , L and W:

$$RC = \frac{S_x}{L \cdot W} \quad (2)$$

Measured date on length and width of avocado leaves in two trials (local soil) and hand prepared substrate (sandy loam) were calculated using formula:

$$S_i = L \cdot W \cdot RC, \quad (3)$$

where S_i – calculated leaf square, [cm²].

RESULTS

The particle size assessment allowed establishing that local soil texture characterised as silt, and handmade substrate as silt loam. It is known that optimal sand content is main pre–requisite to provide infiltration process during vegetation period.

The data on sand content in local soil (Silt) and handmade substrate (Silt Loam) are shown in the figure 2. It was established that the share of sand fraction in in local soil is less than 2 times comparative to handmade substrate.

Figure 2 – Sand fraction content in local soil and handmade substrate, %

The data on underground water ions content are shown in the Table 1.

Table 1. Ions content of the underground water, mg/L

Ion	F	Cl	NO_2	Br	NO_3	SO_4	Na	K	Mg	Ca
Content [mg/L]	0.32	66.64	0.06	0.38	41.10	116.71	60.89	4.04	56.89	55.71

There is different assessment on suitability of water for Irrigation including irrigation coefficient known as SAR (Sodium Adsorption Ratio):

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}} = 8.0$$

In our case SAR of the groundwater is 8 and may be estimated as permissible (Table 2).

Table 2. Suitability of Water for Irrigation

Quality	SAR	pH
Exelent	3	6.5
Good	3–5	6.5–6.8
Permissible	5–10	6.8–7.0
Doubtful	10–15	7.0–8.0
Unsuitable	>15	>8.0

It was known that avocado develop severe leaf burn if the SAR of the irrigation water is more or about 6–10 (*Branson and Gustafson, 1971*). In our case SAR of the local ground water is 8. Avocado seedlings were irrigated with ground water last three months. It was connected with our first task to see impact of tested soil on leachate pH, EC and chemical content. The two

portions of data obtained are shown to compare local soil and handmade soil substrate in pH and EC (Figure 3 and 4).

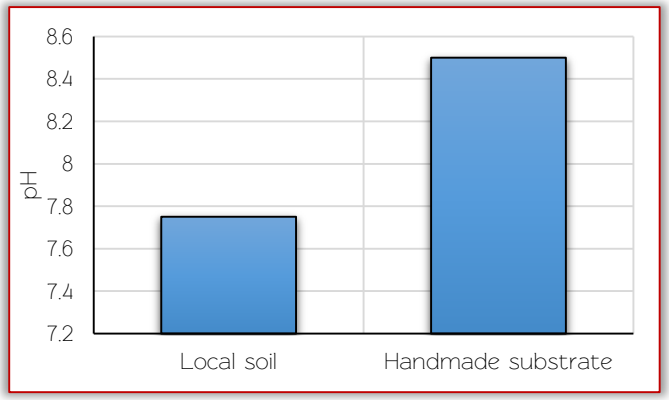

Figure 3 – Leachate pH

Figure 4 – Leachate conductivity, ds/m

American scientists from California Davice University established that maximum yields of 'Hass' avocado on Mexican seedling rootstock are not achievable when the average annual salinity of irrigation water, including rainfall, is greater than '0.6 dSm^{-1}(*Oster et al., 2007*). An ECe of 2 dS/m could be a salinity level that limits water uptake (*Bernstein and Francois, 1973*) by Mexican seedling rootstocks. In our case the leachate pH and conductivity was between 7.8–8.5 and 1.85 to 2.05 ds/m correspondingly.

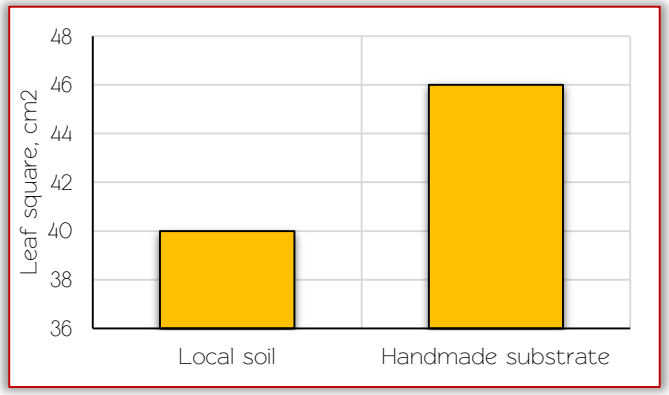

Figure 5 – Leaf square of avocado growing in silt local soil and silt loam substrate, cm^2

The meaning of ratio coefficient of avocado leaves, obtained after calibration procedure was 0.61.The data obtained for two trials (local soil and silt loam substrate) are shown in the figure 5.

It was established that leaves square of avocado plants growing in silt loam substrate is more than 15 % comparative to silt local soil. This difference can be explained more high level of irrigated water through handmade substrate with infiltration comparative with local soil.

CONCLUSIONS

It was established that local soil texture characterised as silt, and handmade substrate as silt loam. It is known that optimal sand fraction content is main pre–requisite to provide infiltration process during vegetation period. It was established that the share of sand fraction in in local soil is less than 2 times comparative to handmade substrate.

Sodium adsorption ratio of irrigated ground water was estimated as 8 or permissible. Leachate pH and EC of local soil were a little bit more than in handmade substrate.

It was established that leaves square of avocado plants growing in silt loam substrate is more than 15 % comparative to silt local soil. This difference can be explained more high level of irrigated water through handmade substrate with infiltration comparative with local soil.

Obviously, the best opportunities for infiltration of irrigated water are the leading factor in ensuring the development of the Avocado plant.

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