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Research article

Study on root density of Picual and Manzanillo olive trees root system at different soil types

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Abstract

The present study was conducted on two olive cultivars trees grown in two different soil types at Suez governorate and Katatba area. The variation in fibrous root distribution, density of soil was determined by intensively sampling four years old Picual and Manzanillo trees (planted originally as cutting) and grown at the two locations during 1994 – 1995. Three trees of each cultivar were sampled. Root samples were collected using an auger 8.5 cm in diameter to a depth of 120 cm (in 30 cm increments) from the four different directions of each tree. Fibrous root samples were placed in plastic bags, transported to the laboratory, washed and then root length measured later, fibrous roots were transferred to paper bags and oven dried at 70 C for 48 hr and then weighed. Fibrous root data of the olive cultivars at different soil depths were used to calculate means for root density (root dry weight mg/cm^3 soil), root distribution as a percentage of total weight. Main conclusions could be summarized as follows: 1. Fibrous root density (Dry wt. mg/cm^3 Soil) of olive trees was significantly affected by cultivar and soil type. 2. Fibrous root density ranged from 2.5 mg/cm^3 to less than 0.02 mg/cm^3. Mean fibrous root density generally decreased as sampling depth increased, and as the distance from the tree trunk increased, while, the direction had no effect on the fibrous root density.

Key words: Root density, Picual, Manzanillo, Soil types.

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1. Introduction

The olive tree (*Olea europaea* L.) is an important crop in terms of both its commercial value and the role it plays in the rural economy of the Mediterranean region, which is home to millions of olive producers. It is expected that its area of cultivation will increase mainly in the countries located in the south and east of the Mediterranean basin [1]. A plant's root system is a highly organized structure that not only serves as anchorage but also in the acquisition of water [2]. The effect of soil properties on root development has been extensively studied by many investigators. Fernandez et al. [3] in a trial on two soil types (sandy loam and clay loam) root distribution and root activity of the olive tree (cv. Manzanillo) was influenced by soil characteristics such as texture and depth.

Studying the relationship between soil properties and structure of the root system for citrus and other fruit species [4], as well as Sparling MB [5] found that the characteristics of the root system changed according to physical and chemical properties of soils. The influence of soil conditions on root development of citrus trees was investigated by Patt J et al. [6] who reported that soil aeration was found to influence root density, and a critical limit of 9 to 10% air space at field capacity was apparent. The mean depth of rooting ranged from 2.8 to 4.6 m for a range of cultivars [7]**.** Wiedenfeld et al. [8] studied the effect of soil texture on citrus root development and tree vigor, they showed that as soil clay content increased, the citrus root density decreased. The effect of tree spacing on root distribution was studied by several investigators. For instance, Pisanu and Corrias [9] in their trial on the root system of olive trees under intensive cultivation showed evidence that root of trees spaced 2 m apart in a row were forced to develop largely in the inter rows, while those spaced 1 m apart develop roots towards the outside. With Manzanillo olive cultivar, Fernandes et al. [3] disclosed that the closely spaced trees had more small roots than wider spaced trees.

In the deep Sandy soil of Florida, fibrous root distribution of 16-year- old "Pineapple" orange trees on rough lemon rootstock was reported. The trees were grown at different spacing (3.5x4.6 m, 4.6x6.1 m, and 6.1x7.6 m). Fibrous roots penetrated to 1.9 m and were well distributed, over 50% were below 37 cm. Lower root densities were found for trees at the widest spacing and there was some evidence of overlapping of root systems at two closer spacing. Maximum fibrous root density was approximately 1.9 mg/cm^3 of sand, root competition was considered not likely to be a primary limiting factor in higher density plantings grown under comparable conditions [10]. The results showed that spaced equidistant in both directions (4.5x4.5 m) had significantly the lowest fibrous root percent under the tree canopy (41%) while those spaced at 2.5x6.0 m had a significantly highest proportion (65%). In another investigation on tree spacing effect on citrus root density, Whitney et al. [11] suggested that root density of the 7- year-old trees was greater at the 4.5x2.5 m spacing and generally decreased with depth.

The main aim of this investigation was to study the root density of Picual and Manzanillo olive tree root system at different soil types.

2. Materials and Methods

The present study was conducted on two olive cultivars trees grown in two different soil types at Suez governorate and Katatba area. The variation in fibrous root distribution, density (mg. dry wt / cm^3 of soil) was determined by intensively sampling four years old Picual and Manzanillo trees (planted originally as cutting) and grown at the two locations during 1994 – 1995.

Location 1: Trees were grown in a sandy loam soil at Katatba Table l spaced at 5x5 m and irrigated by a drip irrigation system through two meters 50 cm apart from both sides of the tree (each tree irrigated about 16 L/hr, for six hours daily).

Location 2: Trees were grown in a sandy clay loam soil at Suez governorate (Table 1); spaced at 6x6 m and irrigated by a drip irrigation system through two meters 50 cm. apart from both sides of the tree (each tree irrigated about 25 L/ hr for two hours daily). Three trees of each cultivar were sampled. Root samples were collected using an auger 8.5 cm in diameter to a depth of 120 cm (in 30 cm increments) from the four different directions of each tree. On each direction, samples were collected horizontally at 50,100 and 150 cm from the tree trunk Fibrous root samples were placed in plastic bags, transported to the laboratory, washed and then root length measured by the grid inter-section method [12]. Later, fibrous roots were transferred to paper bags and oven dried at 70 C for 48 hr and then weighed. Fibrous root data of the olive cultivars at different soil depths were used to calculate means for root density (root dry wt. mg/cm^3 soil), root distribution as a percentage of total weight.

Table 1. Mechanical analysis of the soil at Suez and Katatba

Location	Coarse Sand	Fine Sand	Silt	Clay	Class texture
Suiz	23.2	25.4	13.7	26.7	Sandy clay loam soil
Katatba	54.7	23.4	10.7	11.2	Sandy loam soil

Statistical analysis procedure

All data were subjected to statistical analysis according to procedures reported by Snedecor and Cochran [13]. Treatment means were compared with the least Significant Difference test (L.S.D.) at the 5% level of probability of experimentation.

3. Results and discussion

The variation in fibrous root distribution, density (mg dry weight/cm^3 of soil), were determined by intensively sampling four years old Picual and Manzanillo olive cultivars grown at two different locations. The present study included 5 main factors (i.e. cultivars, soil type, vertical distribution, horizontal distribution and direction).

Root density (mg of fibrous root dry weight/cm^3 of soil).

Regarding the effect of the main factors on the root density, it was found that all factors except directions had significant effect on fibrous root density (Figure 1). Mean fibrous root density of Manzanillo had significantly higher root density than that of Picual (2.77 and 2.03 mg/cm^3 respectively). For soil type, mean fibrous root density of olive trees had significantly higher values in sandy loam soil than sandy clay loam soil (3.67 and 1.13 mg/cm^3 respectively). Root density of olive trees decreased as the depth increased, it was noticed that fibrous root density at the depth 0-30 cm had a significantly the highest density (3.50 mg/cm^3). Root density at 30-60 and 60-90 cm were 1.03 and 0.27 mg/cm^3 respectively. Regarding horizontal fibrous root density, it was clear that density decreased as the distance from the tree trunk increased. Mean fibrous root density at 50cm from the tree trunk had a significantly the highest density as companied to the other distances (i.e. 100 and 150 cm) (2.76, 1.25 and 0.76 mg/cm^3 respectively). Direction had an insignificant effect; however, East-West direction had a higher root density than North - South. It is worth mentioning that the direction of the lateral irrigation line was in the East-West direction. When the effects of significant interaction on the root density were considered, data presented in (Figure 2) showed that Manzanillo cultivar had a higher fibrous root density than that of

Picual. Root density for both picual and Manzanillo cultivars had a higher values in sandy loam soil than that of sandy clay loam soil (1.53, 0.50, 2.14 and 0.63 mg/cm^3 respectively). However, interaction between factors of the cultivars and soil type had a significant effect on root density. From that, it is quite clear that the pattern of fibrous root density of the two cultivars differed according to soil type.

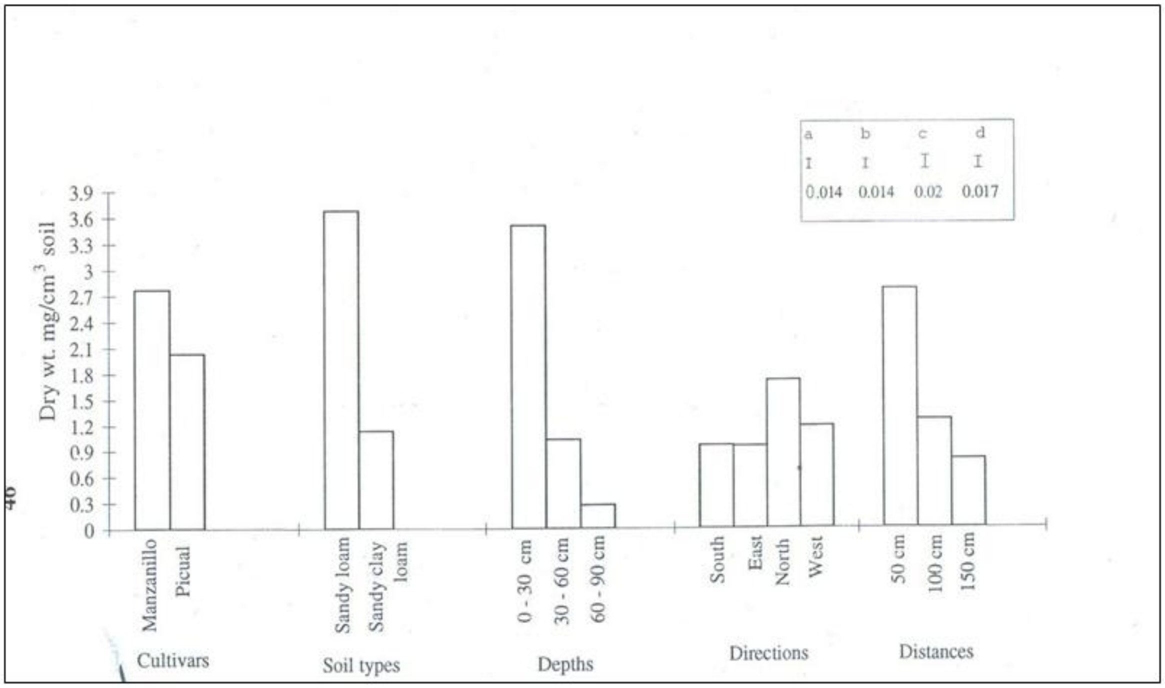

Figure 1. Effect of cultivars, soil types, sampling depths, directions and distances from tree trunk on fibrous root density (Dry wt. mg/cm^3 soil). Vertical bars (a, b, c and d) represent L.S.D. (P=0.05) values for cultivars, soil types, sampling depths and distances from tree trunk respectively.

Fibrous root density was affected by soil types and soil depths. Root density of olive trees in sandy loam soil had significant higher values than that of sandy clay loam soil at all depths (Figure 3). However, interaction between soil types and soil depths had significant effect on root density. The highest fibrous root density of olive trees in sandy loam soil and sandy clay loam soil occurred at 0-30 cm depth (2.54 and 0.70 mg/cm^3 respectively), while the lowest root density for both two soil types occurred at 60 - 90 cm depth (0.28 and 0.02 mg/cm^3 respectively). Consequently, it can be observed that fibrous root density decreased as the sampling depth increased.

Regarding the interaction between cultivars x depths, cultivars x distances and soil types x distances, the data presented in Figures (4), (5) and (6) showed an insignificant interaction effect on fibrous root density. In this respect the root density of both studied cultivars at certain soil depth, distance and / or soil type, had approached values.

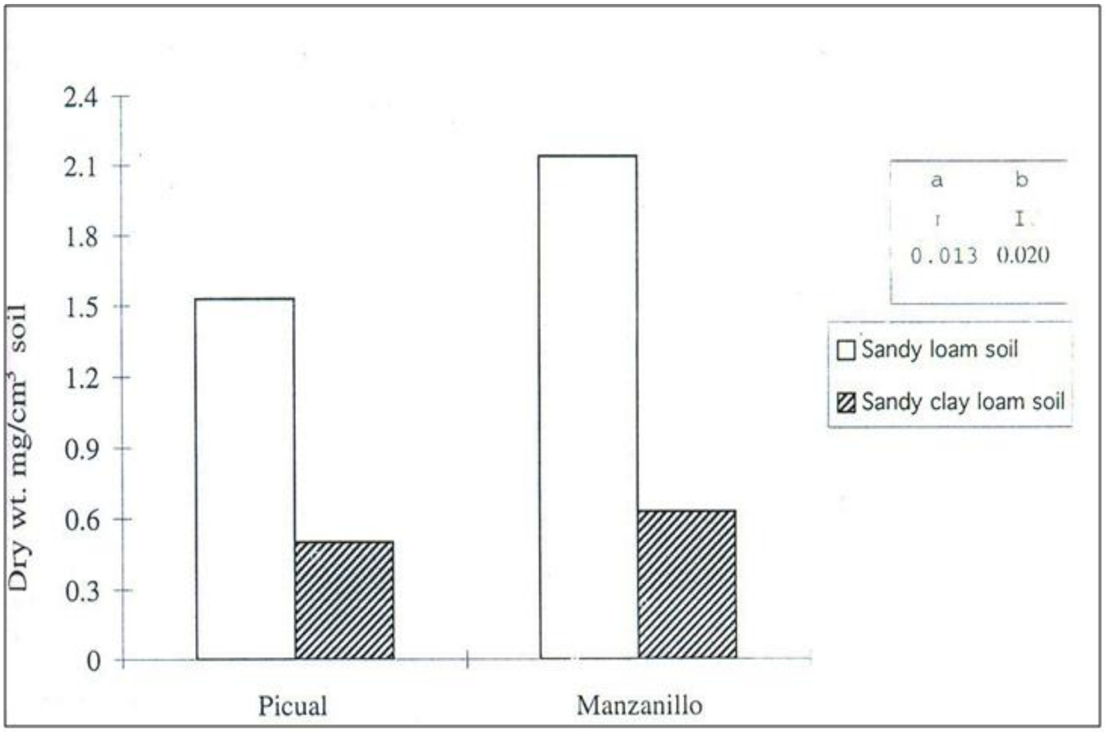

Figure 2. Effect of cultivars and soil types on fibrous root density (Dry wt. mg/cm^3 soil). Vertical bars (a and b) represent L.S.D. (P=0.05) values for Manzanillo and interaction between two cultivars.

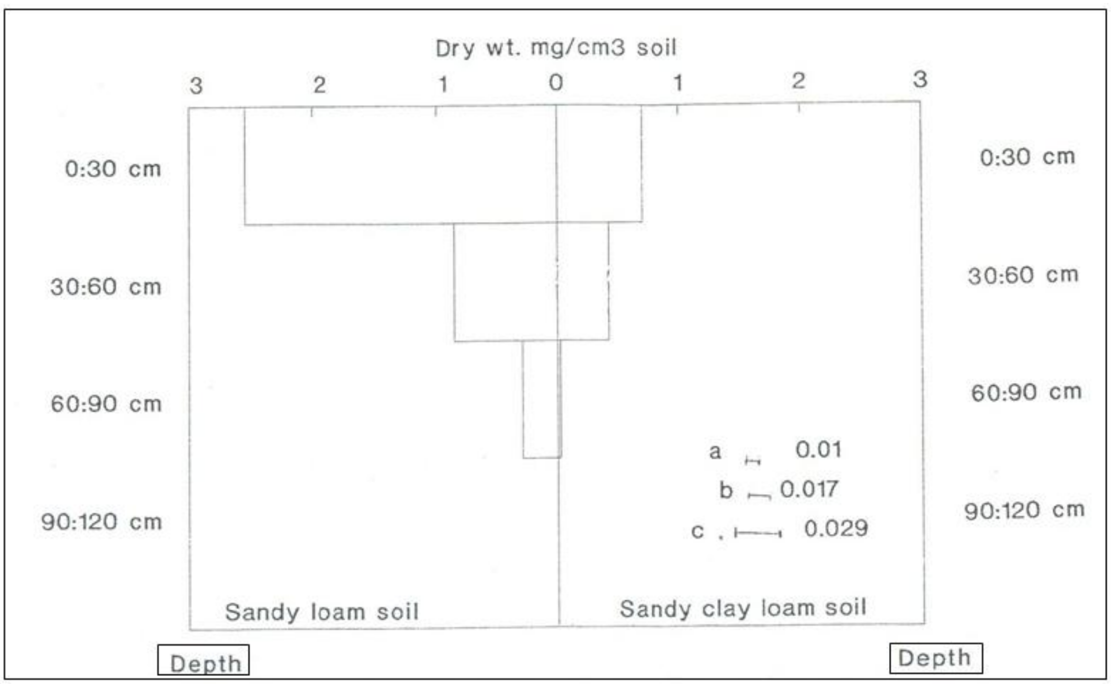

Figure 3. Effect of cultivars and soil types and sampling depths on fibrous root density (Dry wt. mg/cm^3 soil). Vertical bars (a, b and c) represent L.S.D. (P=0.05) values for sandy clay loam, sandy loam soil and interaction.

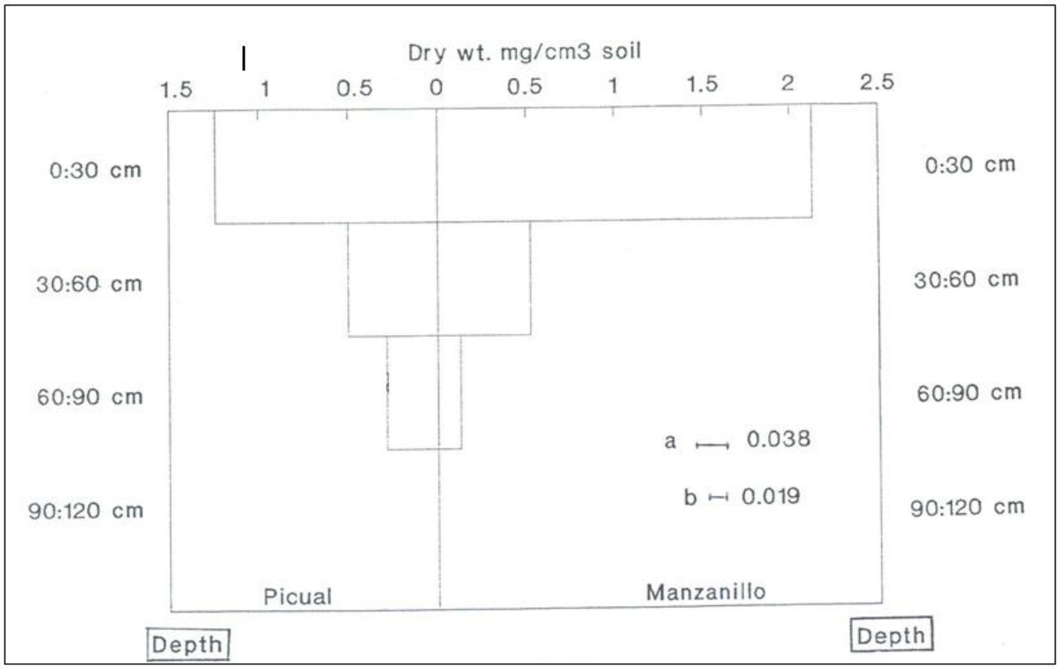

Figure 4. Effect of cultivars and sampling depths on fibrous root density (Dry wt. mg/cm³ soil). Vertical bars (a and b) represent L.S.D. (P=0.05) values for Manzanillo and Picual.

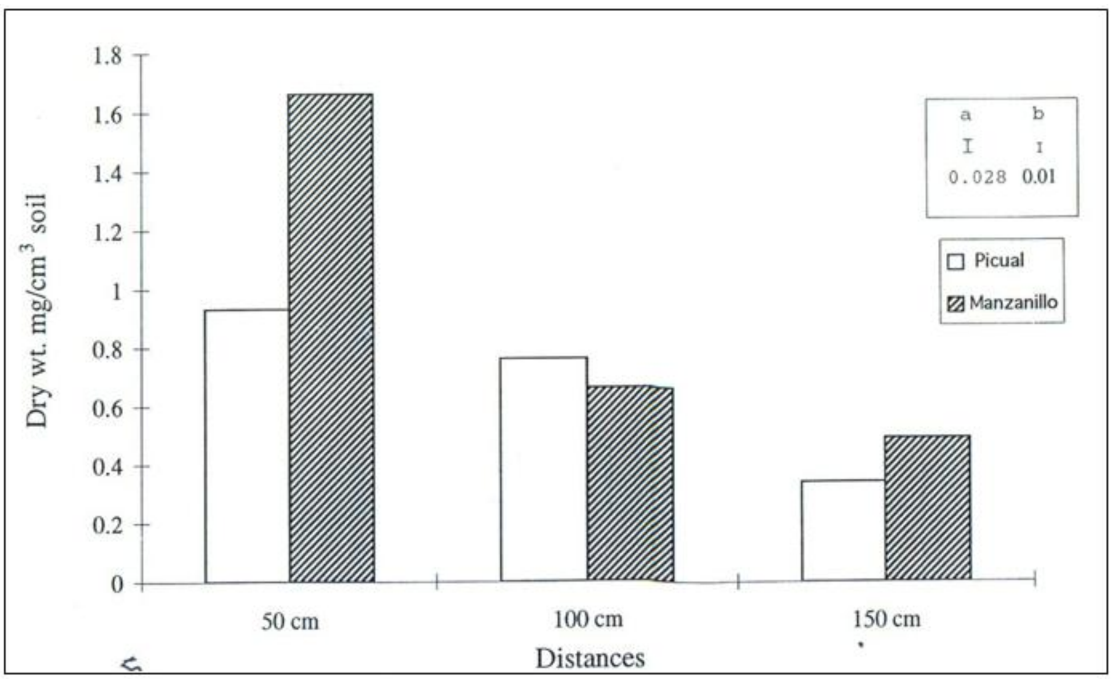

Figure 5. Effect of cultivars and distances from tree trunk on fibrous root density (Dry wt. mg/cm³ soil). Vertical bars (a and b) represent L.S.D. (P=0.05) values for Manzanillo and Picual cultivars.

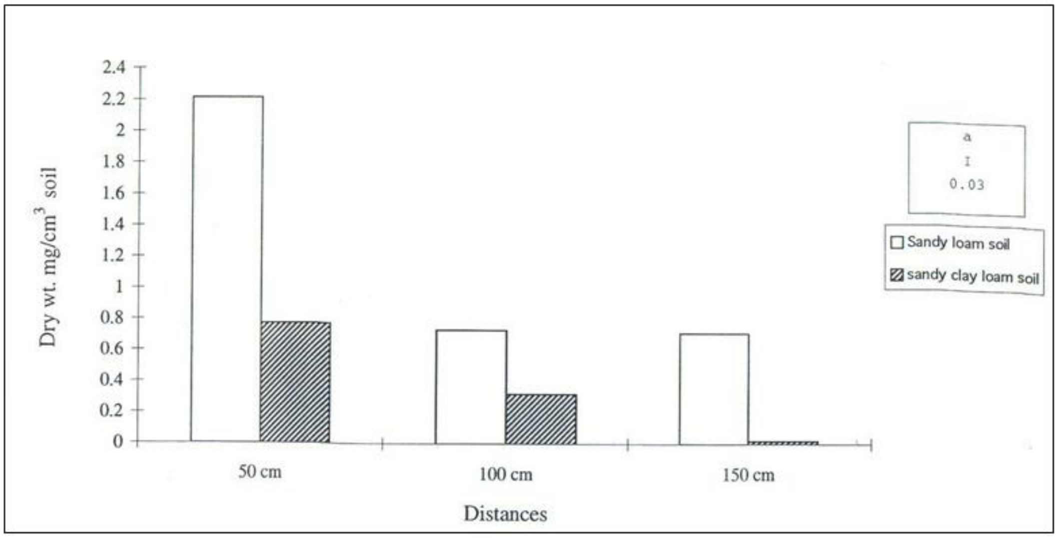

Figure 6. Effect of soil types and distances from tree trunk on fibrous root density (Dry wt. mg/cm^3 soil). Vertical bars (a) represent L.S.D. (P=0.05) values for sandy loam soil.

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