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SPATIAL DISTRIBUTION OF AVOCADO (*Persea americana* Mill) ROOTS UNDER DRIP AND MICROSPRINKLER IRRIGATION

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Abstract

Spatial distribution of roots of adult avocado trees in two different soil types irrigated by drip and microsprinkler systems were studied. Root density was measured in 2 orchards at La Palma Experimental Station, Quillota, Chile. It was determined that the greatest abundance of roots is found during fall, in heavy soil with drip irrigation, among 25 and 50 cm deep and 170-200 cm from trunk.

1. Introduction

Vellidis, Smajstrla and Zazueta (1990) commented on the importance of the study of root distribution standards, spatial distribution of roots and soil water extraction in order to clearly identify the area of major root activity and to increase the precision of irrigation and fertilizer management. This is particularly important in the maintenance of an oxygen supply when avocado is cultivated in "heavy" (clay) soils in which it is necessary to minimize the danger of saturation decreasing, consequently, the susceptibility of the tree to root rot.

Spatial distribution of roots is affected by the volume of wetted soil (Osiadacz 1994) and quantity and frequency of water applications (Levinson and Adato 1991). This was confirmed also in Quillota, suggesting that root distribution is strongly associated with the irrigation method (Villablanca 1994).

The knowledge of the association between the spatial distribution of roots and the irrigation method in diverse soils will allow: i) to establish improved irrigation methods conforming with the particular orchard's soil characteristics; ii) accurate determination of the site to locate soil moisture monitoring instruments for each soil type, irrigation method, and irrigation frequency requirements. The objectives of this investigation, therefore, are to study the simultaneous effects of 2 irrigation methods (drip and microsprinkler), and 2 soil types (clay-loam and sandy-loam) in avocados root distribution system.

2. Materials and Method

Observations were made of root systems of adult cv. Hass avocados, irrigated by drip and microsprinkler methods at La Palma Experiment Station in Quillota, Chile. The area has a Mediterranean climate, with deep, sedimentary soils of coluvial origin. The heavy phase of the soil has 2 clay-loam layers, with a third of sandy-loam interspersed with small stones. The light

phase of the soil is loam at the first layer with small stones, and clay-loam at second and third layers with abundant stones as large as 15 cm in diameter.

Orchard A is planted at 10 x 10 m and irrigated with two microsprinklers/tree located over the rows at 3.5 m from the trunk with a discharge of 36 l/hr each, with wet diameter of 6.2 m. Orchard B the planting distance is 9 x 9 m, irrigated with 12 drippers/tree at 1 m in 2 lines located 1.5 m from the trunk with a discharge of 2.9 l/hr per emitter. Homogeneous trees were chosen from both orchards based on their size, vigor, health and load (medium to heavy). Heavy and light soil phases are present in both orchards.

Root density measurements (number of roots/cm^2) were taken from 4 trees in each orchard at 3 stages of the growth season. White roots with a diameter of less than 2 mm were counted, on the wall of a radial trench constructed toward the trunk of each tree (60 x 75 x 330 cm). To count the roots the entire wall (75 x 330 cm) was sampled, choosing at random 30 squares of 4 cm^2 each on a transparent squared paper of 480 cm^2 in total. For each season, root distribution isolines were constructed with an average of 4 trees per category of soil/irrigation.

A total of 558.7 (microsplinker) and 594.2 mm (drip) of irrigation water was applied in the corresponding orchards. The precipitation was 250.3 mm/year, ocurring from May to July, and the evaporation of the Class A pan reached 1142.5 mm/year.

3. Results and Discussion

Results indicate that the total density of the active roots (TDAR) is variable in quantity and location depending on the season in which they are measured, soil and irrigation method. The most important of these factors, however, is season (growth period). The number of roots found in fall is more than double the number found in the other seasons, principally because this is when the roots are in their *first phase of rapid growth, in* accordance with the avocado's phenology curve determined for Quillota (Tapia 1993; Whiley and Wolstenholme 1990). This effect is more pronounced in microsprinkler in which the ratio increases 3 to 1.

Soil type and irrigation methods are secondary factors but of similar effects. Heavy soils obtained 25% more roots than light ones, and 30% more roots were counted in trees under drip irrigation than those irrigated by microsprinkler. In all cases more than 70% of the active roots were found deep (50-75 cm) and in the intermediate soil layer (25-50 cm), 170-220 cm apart from the trunk. The main differences in TDAR among seasons was recorded in the superficial soil layer.

3.1 Drip irrigation

Maximum TDAR was found in fall, in the superficial soil layer of heavy soil. This was reduced to a sixth in spring, and later in summer increased to a half of TDAR in fall. A similar variation pattern was observed for light soil, even though fall TDAR presented a half as many roots as were found in heavy soil.

Considering that variations in the intermediate (25-50 cm), and deep (50-75 cm) soil layers, are in the same direction but of significant less magnitude than in the superficial, the fault of persistence of active roots in this layer should be attributed, principally, to unfavorable micro-environmental conditions like, for example, the air/water balance. Winter rains can produce easily temporary saturation in heavy soils.

The areas of greatest root concentration (AC) in light soils are always found in the intermediate soil layer between 170-200 cm from the trunk. Seasonal variation in depth as well as root distance is observed in heavy soils. In fall, the AC is found in the deep soil layer at 190 cm from the trunk; in spring the same density between the intermediate and deep soil layer are found at about 200 cm from the trunk, while in summer, the AC is found in the intermediate soil layer, 300 cm from the trunk. The greater distance where roots are located in summer is probable due to the high moisture levels in the area close to the emitter, caused by high frequency and prolonged irrigation.

3.2 Microsprinkler

Observations showed that superficial soil layer hold 15% of total roots as a maximum, with the exception of light soil in fall (44%) and spring (3 1%). Additionally, the observed TDAR is 80% greater in fight soils. These facts allows to suggest that the microsprinkler irrigation system restricts root growth in heavy soils, possibly as a consequence of an unfavorable air/water balance in soil, which limits the interchange of gases and the accumulation of inadequate substances derived from anaerobic reactions (Venegas 1990).

Consequently, in heavy soils the AC is found in the intermediate and deep soil layers at a distance of 190 and 210 cm, except in summer when it is removed toward the periphery, at a distance of up to 280 cm. In light soils the AC is found in the upper soil layer and at the same time distance is reduced to 120-150 cm from the trunk. It's possible that some points are saturated, at least around the emmissors, in the first soil layer of heavy soils since the precipitation of the microsprinkler used in the study varied between 3.41 mm/h at 50 cm to 1.40 mm/h at a distance of 300 cm. The nominal average is 1.55 mm/h, which is obtained only at a distance of 150 cm. Nevertheless, in accordance with the emmissor discharge curve, approximately 40% of the wet area received precipitation greater than the nominal average. This fact could inversely, favor root growth in light soils which naturally retain less water.

Munoz (1988) indicated that the quantity of roots decreased at almost the same rate that the microsprinkler discharge, concluding that a greater number of roots are found where ever there is a greater quantity of water. This is contrary to what was found in this study. No roots were found in the first, most humid soil layer of the sectors closest to the microsprinkler in heavy soils. These findings coincide with the work of Villablanca (1994).

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