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Laterals Distribution on the Principal Root in Avocado Seedlings (*Persea americana* Mill.)

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Summary

Data on the first order laterals distribution as well as the angle they form with the principal root in avocado seedlings generated from seeds of the wild "criollo" of Mexican race, Fuerte, and Hass cultivars, are presented and discussed. Both characters were evaluated at three shoot sizes of 5, 15, and 45 cm height, taking three seedlings into account per measurement. The principal root was divided into equal number of zones with the initial point at the base. Differences were found among plants in the distribution of first order laterals as well as the angles formed with the principal roots. The criollo seedlings presented higher numbers of laterals in the adbasal part, the Hass type in the medial part of the main root (shoot size 15 cm). The roots distribution at the last stage of 45 cm shoot height was more uniform in the Fuerte type, with a shift of the peak in others. The angle the laterals formed was above 60 ° in most of the cases observed, with some plants showing lower or higher values. The stability of both characters, especially the angle values, should be considered in future study of seedlings or clonal stocks in the field conditions.

Introduction

The horizontal, as well as the vertical, root distribution in the soil depends upon the genetic as well as phenotypic responses. The angle the lateral roots form with the main root, at seedling stage, results from the interaction of gravitropic and hyponastic forces. The place and number of laterals which appear along the principal root, as well as the angle they form, determine the soil's exploration capacity by a root system. These characters, together with the roots diameter and roots elasticity, define the root system's mechanical resistance to winds or other forces acting upon the root-stem base. The resistance of avocado roots has been estimated and, according to Moutounet *et al.* (1977), it is higher in *Psidium guajava* L.

A wide variation was found in the angles the scaffold roots (2 cm diameter) were forming with the stem axis in three year old trees of cv. Hass/Mexican race in rather unusual soil conditions near the Volcan Paricutin, Michoacán, Mexico. A general tendency was to form roots with the angle value and its frequency as follows in a total of five trees evaluated (Sandoval-Heredia and Borys, 1984): 5°-30°, eleven roots; 31° - 60°, four roots; and 60°-90°, also four scaffolds. In these trees, the scaffolds were

directed toward deeper soil layers of high fertility levels. The same study showed a wide variation between the trees in the distribution of horizontal and vertical roots. In other comparative studies at the seedling level, morphological variability in the root system of P. *americana* Mill, and *P. schiedeana* Nees, was stated to be present (Borys, 1988). There is a possibility that the first order laterals will form the scaffold (skeletal) roots of a mature trees.

Materials and Methods

Seeds were obtained from the wild-grown criollo (Mexican race), and the Fuerte and Hass cultivars, subjected to heat treatments, according to the procedure of Durbin (1957), and planted in disinfected river sand. The plants were raised in polyethylene bags of 20 x 40 cm. One seed was planted per bag. The plants were grown in the greenhouse with uncontrolled temperature from November 1985 until August 1986, giving a commercial fertilizer solution and water as needed. For this study, plants at 5, 15, and 45 cm of shoot height were selected, washing the roots from the sand and taking the respective measurements.

Results and Discussion

Distribution of the first order laterals. The evaluations were made when the plant-shoots were of 15 and 45 cm of height.

The laterals, at the 15 cm stage, show an accumulation nearby the root basis (shoot-root union) in seedlings of the criollo and Fuerte types (Fig. 1-IICr, 1-IIF). The seedlings of the Hass type shifted the concentration toward the middle part of the principal root. Among the avocado seedlings of the criollo and Fuerte, some differences seem to be present in the localization of the zone of major accumulation of laterals.

The laterals distribution at the next stage of shoot size (45 cm) presented more uniform distribution along the root axis (1-IIIF seedlings, Fig. 1). The criollo and Hass seedlings showed some differences among the plants; e.g., the plant 9 *versus* plant 7 (Fig. 1-IIICr). The differences in laterals distribution among the seedlings became less distinct with the advanced size of the shoot. Comparing Fig. 1-IIICr with Fig. 1-IICr, one should note the displacement of roots-forming zone toward the adapical part of the main root.

Angle between the laterals and the main axis. Mostly, the angle the laterals were forming was above 60°. The laterals located in the adbasal pan of the main axis showed a potential of formation of horizontally-oriented roots. At the first stage of shoot growth, no differences appeared between the seedlings (Fig. 2-ICr, Fig. 2-IF); but at later stages, such variation is clearly evident (Fig. 2-IICr, Fig. 2-IIH, Fig. 2-IIICr).

The data seem interesting and promising, although they are restricted to small-sized plants. Interesting, because they indicate that the roots vary in the angle value among the individual plants at such an early stage of growth. Promising, because in an earlier investigation of avocado skeletal roots distribution, under field conditions, we found a range of variability. Some of these roots do indicate the formation of horizontally-, others vertically-oriented, skeletal roots. Still others presented roots of variable angles

(Sandoval-Heredia and Borys, 1984). It has to be determined if the angles formed in young plants are maintained by mature trees.

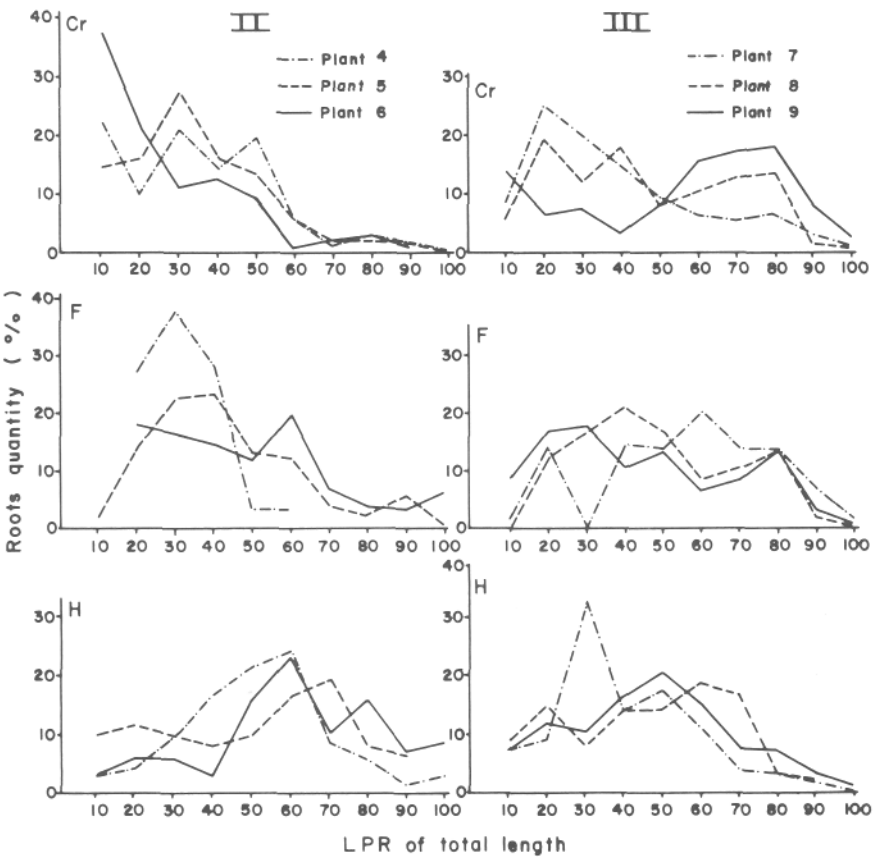

Fig. 1. *Distribution of first order laterals along the principal root (LPR) of avocado seedlings: Cr = Criollo Mexican race, F = Fuerte, H = Hass, when the plants were 15 (II) and 45 cm (III) of shoot height.*

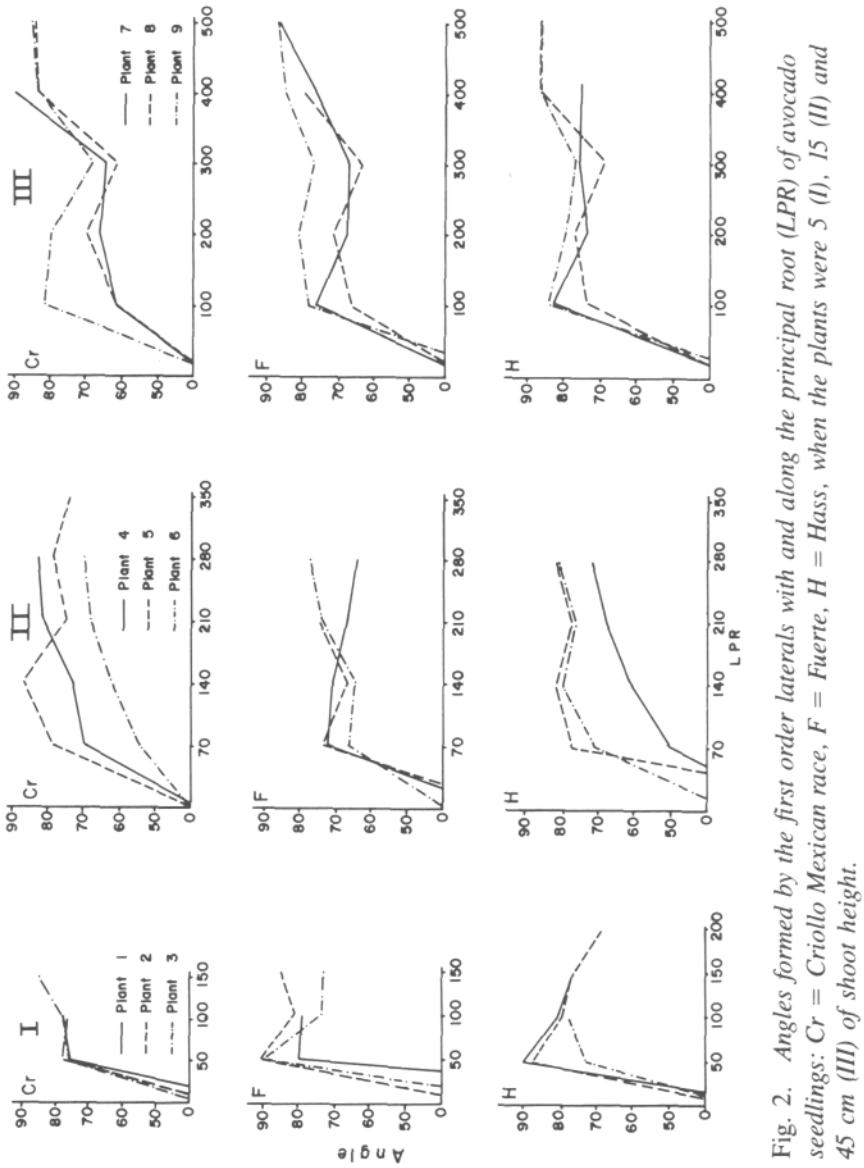

Fig. 2. *Angles formed by the first order laterals with and along the principal root (LPR) of avocado seedlings: Cr = Criollo Mexican race, F = Fuerte, H = Hass, when the plants were 5 (I), 15 (II) and 45 cm (III) of shoot height.*

A practical solution to the problem of a lack of adaptation of avocados to a wide variety of edaphic conditions, such as shallow soil, high water table, faulty drainage, lies in the selection of rootstocks with proper morphological and physiological characters: a shallow one with wide angles of skeletal roots, or a deep one but highly resistant to high water. Shallow root systems combined with high resistance to water stress conditions are lacking. Also, shallow roots combined with high resistance to high soil temperature and excessive soil water are lacking. The lack of rootstocks with well distributed skeletal

roots around the stem basis creates a problem in some avocado plantations (Borys, 1988).

The first laterals, located near the trunk/root junction, form the main static framework supporting the whole tree (crown). Thus, the number, the diameter, and the angles these roots form with the tree axis, as well as their distribution around the main axis, will determine the resistance of a tree to the wind and other components of static forces of the tree crown. It is clear that the soil exploitation depends also from these root characters.

The angles the first laterals form with the main axis, as well as the root distribution along the main axis, vary among the seedlings. We know nothing about the stability of roots characters here reported with the age or due to the procedure applied in tree production and final establishment of plantations. In other plant species, the root angles are genetically controlled.

One expects stabilization and homogenization of characters by means of vegetative propagation of selected material, but we lack information about the root morphological characters of clonally propagated materials. If the maintenance of roots morphological characters in vegetative propagation could be proved, then the potential of avocado roots reported at the seedlings level could be explored in practice (Borys 1988, 1988a).

It is not clear if the loss of the adbasally located laterals on the main root is due to the genotypic factor or the short life span of these roots. In avocado plants, the rate of root death of the first order laterals as well as the rate of regeneration of these roots (reappearance) is unknown. The high frequency of root death and regeneration has been noted by Kolesnikov (1971). Thus, the clearance of the adbasal part of the main root from the laterals and the displacement of the peak of the roots number toward the medial or adapical zone of the main axis are similar to a wave movement. Such patterns of laterals distribution indicate the unstable, constantly changing character (number and position) of the root system.

In avocado trees, the displacement of the fine root zone from the adbasal toward the adapical zone, exterior one, was found to be present, and the data seem to support such a movement. A primary wave of roots displacement may be followed by the next wave; e.g., due to watering patterns in adbasal parts of the tree roots, mulching, fertilizing, etc. The first wave can be compared to the conquer force which is slowly diminishing with the distance from its base (point of departure). With increasing distance from the base, the inhibitory mechanism of apices, or the competitive action, is diminishing between the root apices; and root initials remain dormant at the root base, left behind the main wave. The wavy displacement (formation-death-regeneration-death) of fine roots may form the basic mechanism of continuous soil volume exploration. Thus, the continued movement of the "wheel" can be viewed as a phenotypic elasticity of the avocado root system, as its adaptive mechanism to the constantly changing soil conditions. The root regenerative power is probably genetically dependent (Borys, 1986).

In young plants, the distance at which the laterals appear depends upon the presence of the root apex of the main root, at least in the case of first order laterals. The death or slowing down of the activity of the main root apex results in a rise of the number of new

roots formed, as well as the angle they form with the main axis. Any damage to this point gives similar results.

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