

## Assessment of root growth pattern of Cinnamon (*Cinnamomum verum* Presl)

I. Malavipathirana and S. Subasinghe

Department of Crop Science, Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya, Sri Lanka.

### Abstract

*A series experiments were conducted to study the below ground growth performance of Cinnamon. The experimental design of the pot experiment was Completely Randomized Design with five replicates and each replicate consisted of eight seedlings. In field experiment, randomly selected plants with different ages were selected.*

*The higher root growth was reported in plants grown in silver sand, which, were 123% and 143% higher than gravelly soil and potting mixture respectively. The majority of roots (43%) were confined to the top 5 cm depth of the soil profile, irrespective of media. With increasing age from 1 to 10 months, Number of roots in the top 5 cm soil decreased from 43 to 34% while was increased from 7 to 27% at second 5cm depth level.*

*Root biomass partitioning (biomass of lateral roots to total root biomass), root volume and collar width were significantly higher ( $P \leq 0.05$ ) in silver sand followed by gravelly soil and potting mixture. In the field experiment, the lateral and vertical distribution of roots increased with age but after harvesting, the lateral distribution increased beyond the depth distribution due to profuse branching of roots. In field grown plants of 2-60 years, more than 90% of roots were confined to top 50 cm of the soil profile and the lateral distribution of roots was much higher than depth distribution, which revealed that the effective root zone is 50cm of the soil profile for adopting cultural practices.*

**Keywords:** *Cinnamomum verum* Presl, gravelly soil, silver sand

### Introduction

Cinnamon (*Cinnamomum verum* Presl syn. *Cinnamomum zeylanicum*) is one of the oldest tree spices indigenous to Sri Lanka, belonging to the family Lauraceae. Sri Lanka is the world largest producer and exporter of Cinnamon, accounting for nearly two third of the global output (Central Bank Report, 2003). Cinnamon is the third largest export crop in agriculture sector. It enjoys a virtual monopoly in international trade whereas the other Sri Lankan spices contribute only 2-3% of the trade (www. aspen publishes. com).

Cinnamon is commonly cultivated in the uplands of low country wet zone in Southern part of Sri Lanka. It is concentrated along the coastal belt from Negombo to Matara and in some inland regions of Kalutara, Ambalangoda and Rathnapura covering a total land area of around 25,300 ha (Central Bank Report, 2003). Given the benefits of modern methods of cultivation, crop management, crop protection, production and marketing, it has been envisaged that the world can continue to expect from Sri Lanka, Cinnamon products of prime quality. Since no effective work has been done on root distribution studies on Cinnamon, this study was directed to collect information on the distribution pattern of Cinnamon roots from seedling stage to field plantation.

### Materials and methods

Two separate experiments were conducted. In experiment 1, a pot experiment was conducted at the Faculty of Agriculture, University of Ruhuna, Mapalana, Kamburupitiya. Experiment 2, was conducted in

a existing Cinnamon field at Cinnamon Research Station at Palolpitiya, Thihagoda, Matara. Both experiments were conducted during May to September 2004. Both locations of Mapalana and Palolpitiya are located in the same agro-ecological region of WL<sub>4</sub>. Annual rainfall of the area is about 2352 mm, with the bimodal rainfall distribution pattern. Annual air temperature of two locations is fairly constant around 28° C. The annual relative humidity is about 78%. The predominant soil of the area is red yellow podzolic.

Experiment 1 consisted of three treatments and five replicates arranged in a Completely Randomized Design with each replicate having eight plants. In experiment 2, Cinnamon plants in several growth stages (i.e. one year, two years, four years, six years and 60 years) were selected randomly from Cinnamon Research Station at Palolpitiya.

In experiment 1, polythene bags with dimensions of 12.5 cm in diameter, 20 cm in height and 250 in gauge were filled with three potting media, those of gravelly soil, silver sand soil collected from Nathandiya and mixture of top soil 1: sand 1: compost 1. After their germination, excess seedlings were thinned out leaving one vigorous plant per bag. Six month aged potted Cinnamon plants were taken from the nursery and transferred into the poly bags of 30 cm height and 25 cm width that are containing three different growth media. Seedlings were watered in regular intervals to avoid dry conditions and weed free environment was maintained. Mancozeb was applied as a foliar application to control *Cercospora* fungal disease.

### **Soil profile preparation in field experiment**

A soil pit of 1.5 m in length, 1.0 m in width and 1.0 m in depth was opened in the field site of the Cinnamon Research Station at Palolpitiya to observe the soil profile characters and to draw soil samples to determine soil physical properties. Three soil samples, each at four depths of 0-25, 25-50, 50-75, 100 cm from three walls of the soil pit that was dug to ascertain the soil profile. At the same time, soil samples from the prepared polythene bags were also collected to determine the soil physical properties of three different growth media.

Bulk density of the field site at four different depth levels and polythene bags with three different growth media were determined using Gravimetric method. Specific Gravity Bottle method was implemented to determine the particle density of the media was taken into account in bulk density. Porosity of each soil was calculated using each value of bulk density and particle density.

Texture of the soil at each four depths of the field site and potting media, of gravelly soil, silver sand soil and soil mixture were determined using pipette method with ammonium hydroxide as the dispersion agent of soil. Plants were uprooted and measured their root length, weight, density, volume and root distribution pattern. Root measurements at different layers were taken by removing the bags, dipped in a water bucket so as to entirely submerge to facilitate dispersing soils that stuck with roots. After the specimen was cleaned by removing all the debris using a wash bottle and arrange the root system by using pins so as to lie in normal condition and then photographed.

Tap root, lateral and total root length was measured layer wise. Tap root length was measured from collar region to tip of the un-branched main root, lateral root length taken from commencement to the tip of all roots except tap root and total root length taken as the total of both tap and lateral root length. Fresh and dry weight was taken using analytical balance. Samples were kept in the oven at 80°C for a three-day period before weighing. Root density was taken as root length density, indicates the length of roots per unit volume of soil. The soil was carefully washed away from the roots, and excess water that remained on the outer surface of the roots was allowed to drain. Then volume was determined by the Archimede's principle.

The data were statistically analyzed, using SAS (Statistical Analysis System) software package. DMRT was implemented to stratify the treatment means. Other than that mathematical and graphical presentation were also used.

## Results and Discussion

### Soil physical properties

Silver sand soil had the highest sand percentage while there was no considerable clay particle at all. Table 1 shows the soil texture of each potting media.

**Table 1. Soil textures of different potting media**

Potting media	Sand %	Silt %	Clay %
Gravelly	19.5	12.6	57.8
Silver sand	81.7	18.3	0
Potting mixture	60.8	16.5	22.7

Bulk density, true density and porosity in three types of potting media were shown in Table 2 Silver sand soil had the highest value for porosity compared to other two potting media.

**Table 2. Density and porosity of different potting media**

Potting media	True density	Bulk density	Porosity %
Gravelly	2.32	1.50	35.43
Silver sand	2.55	1.31	48.60
Potting mixture	2.13	1.32	37.69

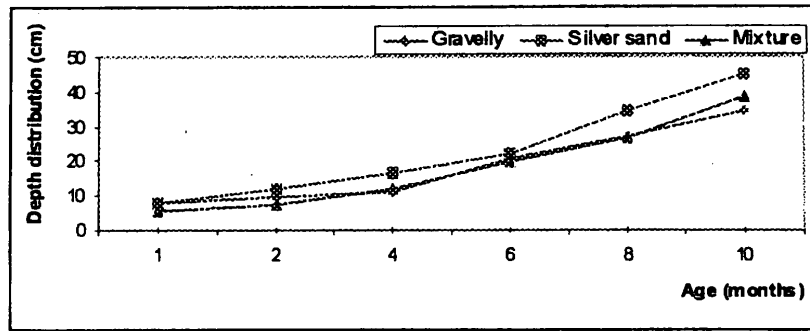
### Soil density and porosity of the soil in Cinnamon grown field

The highest porosity was recorded at 0-50 cm depth layer while the lowest value was at 75-100 cm depth layer and bulk density was vice versa.

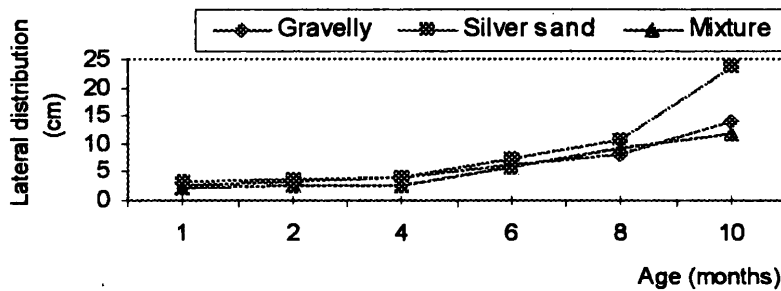
### Root distribution pattern

The root distribution patterns considerably differed in different potting media. Figure 1 and 2 showed that depth and lateral distribution of roots in silver sand soil was significantly higher than that of gravelly soil and soil mixture.

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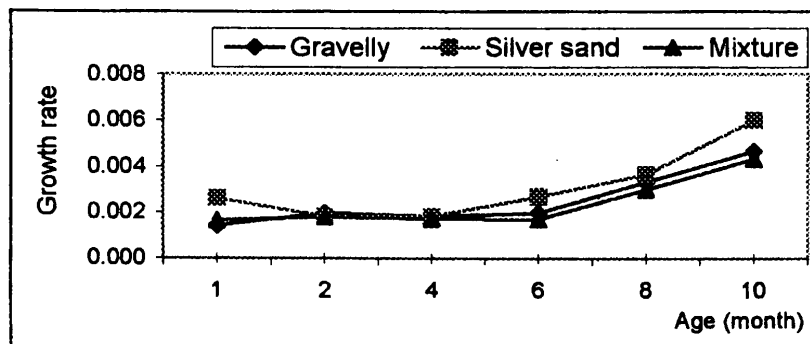
**Fig. 1: Depth distribution of roots in different soil types**



**Fig. 2: Lateral distribution of roots in different soil types**

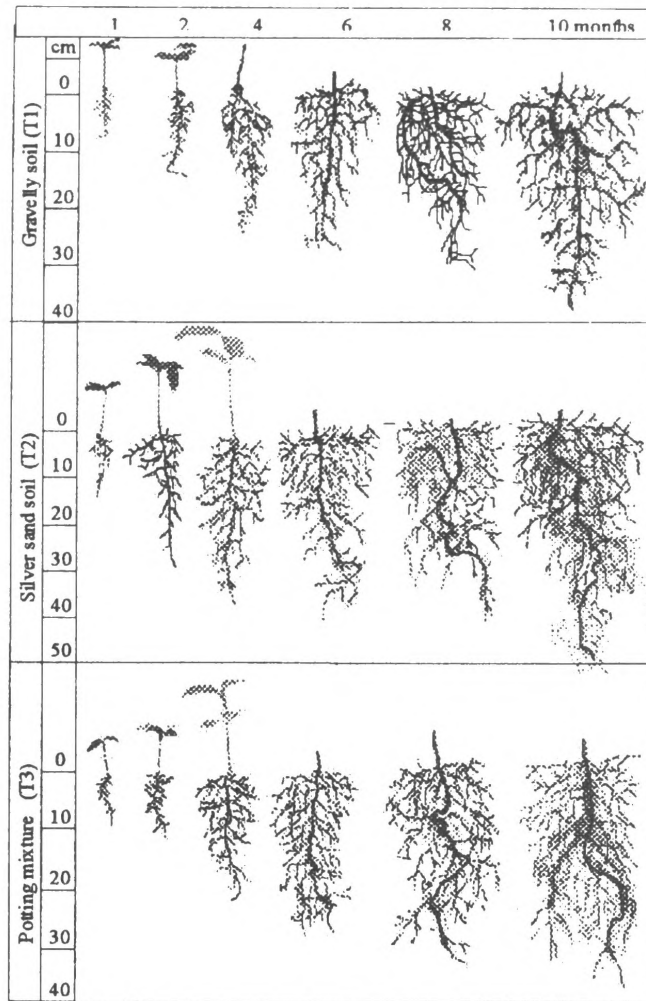
### Root growth rate

Root growth rate in silver sand soil was significantly higher than other soil types after 8 month of age. However, root growth rate in silver sand increased by 27% and 30% respectively compared to gravelly soil and soil mixture (Figure 3).



**Fig. 3: Root growth rate pattern in three potting medias**

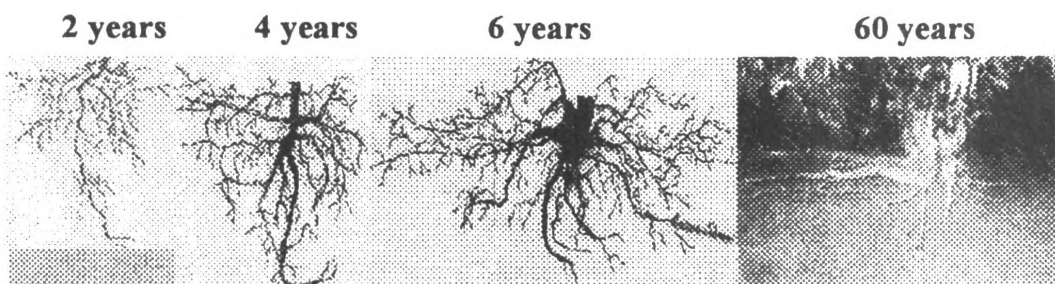
Root distribution in 3 potting media at different stages is shown in plate 1.



**Plate 1: Root distribution in 3 potting media at different stages**

**Root distribution pattern of field grown Cinnamon plants**

In the field experiment, it revealed that lateral and vertical distribution of roots increased with their age, but after harvesting, lateral distribution increased beyond depth distribution due to profuse branching of roots. This character is important in designing resource efficient mixed crop models. Roots of trees often spread laterally well beyond the width of the crown. However the lateral spread of roots varied greatly with site, especially with soil type. For example, Rogers and Booth (1959) found that roots of trees growing on loamy soil extended laterally about twice that of the crown, on clay, about one and a half times; and on sand, three times. The root systems of field grown Cinnamon plants in several growth stages are illustrated in plate 2.



**Plate 2: Root systems field grown Cinnamon at different ages**

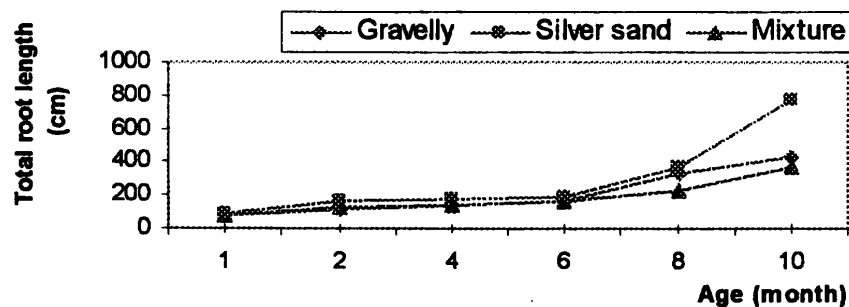
Most of the roots (over 85%) were concentrated in the top 50 cm soil profile in field grown plants (Table 3). It shows that effective root zone was limited to the top 50 cm soil layer. Therefore this area could be considered as an effective root zone for adopting cultural practices.

**Table 3. Percentage of roots at 0-50cm depth level in different ages**

Age (Years)	% of roots at 0-50cm
2	86
4	92
6	92
60	88

### Root growth parameters

All root growth parameters (root number, root length, root dry weight, root volume and collar width) showed higher value in silver sand media compared to other potting media. Also, roots were much deeper and thicker when planted in silver sand as shown in Figure 4. But, Senaratne and Dayathilake (1998) have reported that dense and higher number of roots in vegetatively grown plants were formed in river sand media. Quality of Cinnamon was greatly influenced by soil and Cinnamon production under different geographical areas and environment possess different in quality (Weiss, 2002). It is also reported that the highest quality Cinnamon is produced in Negombo area where “Silver sand”, soil predominate (Purseglove *et al.*, 1981).



**Fig. 4: Variation of root length in different soil types**

### Root density in the soil profile

Root density in each soil type and depth level followed almost the same pattern with their age as shown in Figure 5. Most of the roots of plants grown in gravelly and potting mixture were confined to top 10 cm soil layer, while the roots grew deeper in silver sand media. The number of roots in the soil profile was considered as the key factor in determination of root density.

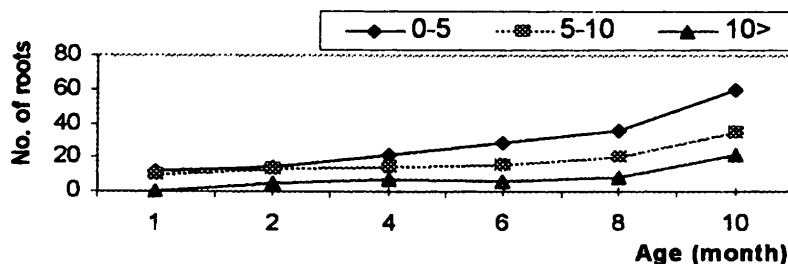


Fig. 5: Variation of number of roots in different depths

### Root biomass partitioning

Root biomass partitioning of three potting media varied in a similar pattern and recorded approximately similar values with their age, as in root density (Figure 6).

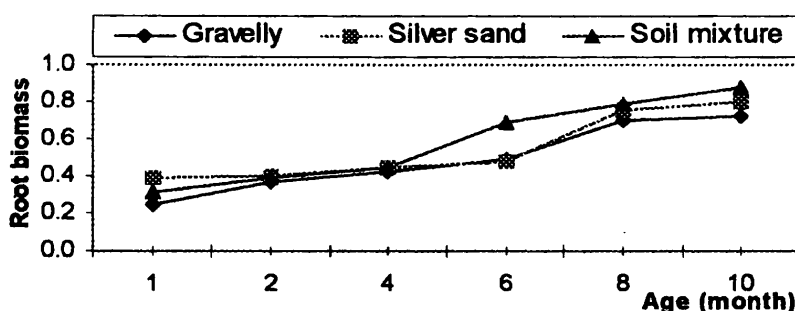


Fig. 6: Variation of root biomass partitioning (lateral roots/total roots) in different soils

### Correlation of root growth parameters

High positive correlation obtained for root weight, root number, root depth and lateral root distribution and collar width, indicated that either one of the parameters could be taken for Cinnamon root studies.

### Conclusions

1. Silver sand media exhibited the highest root growth performance followed by gravelly soil and potting mixture.
2. After harvesting, the lateral distribution of roots increased beyond vertical distribution due to profuse branching of roots.
3. Quantitative figures of roots were in decreasing order towards the deeper layers from the surface.
4. The effective roots zone of Cinnamon cultivation could be considered as top 50 cm depth level of the soil profile.
5. In poly bag seedling in the nursery (up to 10 month), majority of Cinnamon roots were confined to top 10 cm of the soil profile.

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- [http:// www. aspen publishes. com](http://www.aspenpublishes.com) Fig. 3. Root