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AVOCADO SOIL MOISTURE STUDIES

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OPSOMMING

Die wortelsisteem van 'n Fuerte-avokadoboom was oopgegrawe. Die wortels het tot 'n diepte van 3,3 m ingedring en het uitgestrek tot ver buite die boomdrip. Grondvogstudies het aangetoon dat daar groot variasie voorkom in vogverliese in die boonste 900 mm grond. By klein oop boompies is 'n panfaktor van 0,6 gevind en by digte gesonde groot borne 'n panfaktor van 0,20. By die Jong borne was elf besproeiings nodig tussen Maart tot Oktober, maar in die geval van die groot borne, slegs drie besproeiings. 'n Plastiek grondbedekking onderjong boompies het 'n water besparing van 23,8% tot gevolg gehad.

SUMMARY

The root system of an avocado tree was exposed. Roots were traced to a depth of 3,3 metres and to well beyond the drip zone in the top-soil. Soil moisture studies showed that in the top 900 mm of soil there was a wide variation in moisture loss under different situations. A pan factor of 0,6 was found in small open trees and of 0,20 in well foiliated Fuerte trees which had developed a good mulch. Under such circumstances, only three irrigations would be needed during the dry months from March to October with mature Fuerte trees and eleven irrigations would be needed on the young open trees. Plastic mulch placed below young trees resulted in a water saving of 23,8% in the top 220 mm of soil.

INTRODUCTION

A large part of the avocado plantings in South Africa are grown under dry land conditions. Where irrigation is practiced farmers need to be careful not to over-apply water because of the deleterious effects of the Root Rot fungus *Phytophthora cinnamomi* which is the main cause of avocado tree decline in S.A. On HL Hall & Sons, avocados are grown in an area of limited water supplies with the result that the number of irrigations applied is restricted. In spite of this, it has been found that under certain conditions, the moisture level in the top 900 mm of soil remains at a satisfactory level.

These studies on soil moisture loss were done on soils of the Mutton Form, Doveton series (clay content above 35%).

PROCEDURE

(a) The root system of an avocado tree was exposed to a depth of 3,3 metres.

(b) Soil moisture losses were compared under trees of different sizes.

Soil moisture status was determined by drying samples ¡n an oven at 100°C. Where applicable soil moisture contents were determined in the pressure membrane apparatus at 0,1 bar (field capacity) and 1 bar which was used as the upper limit of "available" moisture.

(c) Plastic mulch was placed under small trees. Plastic fertilizer bags were used. These were pierced with a garden fork to allow water penetration, and buried ± 2,5 cm. below the soil surface. Moisture loss below these trees was compared with unmulched trees.

RESULTS

(a) Avocado root system.

The diagram shows three distinct zones in the exposed root system of a thinly foliated tree approximately 8 years old. The tree was approximately 2,4 metres high with a 4,3 to 6,1 metre diameter drip zone. The three zones may be described as follows:

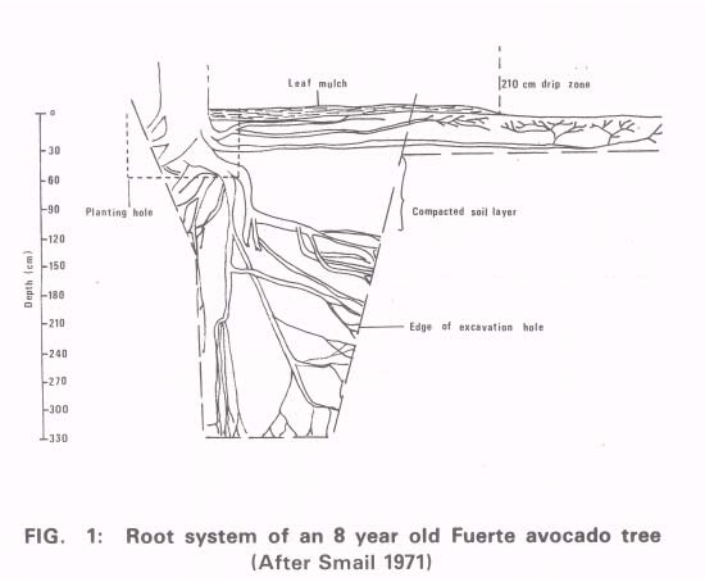

FIG. 1: Root system of an 8 year old Fuerte avocado tree (After Smail 1971)

0 - 350 mm.

Inside the tree drip zone is a leaf mulch 10 - 50 mm thick with very few feeder roots immediately underneath. From 0 - 600 mm from the tree base there is a dense network of roots 10 - 50 mm in diameter, which were growing 4,5 to 6 metres from the tree base. Many of the roots were growing along the top of the compacted layer and had sent feeder roots to the surface.

0,35 - 1,2 metres

This is a compacted zone with very few roots. Studies done by Smail (1971) on these soils showed that bulk density in this zone was 1,48 g/mf as opposed to 1,33 g/mℓ the top soil. Some roots were growing horizontally about 25 mm below the top of the compacted zone; their feeder roots did not penetrate into the soil on either side but followed the same pathway through the soil as the parent root. Feeder roots which were growing up into the lower part of the compacted zone were generally necrotic.

The densest section of the compacted zone appeared to be from 380 mm to 635 mm. The planting hole was dug to a depth of 660 mm. Roots grew almost vertically down from the planting hole before growing out horizontally below the compacted zone.

1,2 - 3,3 metres

While some of the roots were growing out horizontally below the compacted layer, others continued to grow down vertically. From 1,5 metres the root density started to decrease with very few roots being present at 3,3 metres. A few feeder roots were found to be growing up vertically.

This diagram shows the great depth to which avocado roots can penegrate. In these moisture investigations only the top 600 or 900 mm of soil was studied. This is generally regarded as the most important part to keep at a satisfactory moisture level and although the greatest concentration of roots occurs in the top 350 mm, there is also a significant amount of root below the 900 mm depth which is capable of withdrawing part of the plant's water requirements.

(b) Soil moisture studies

Moisture content of the soil was measured under trees of different sizes to compare rates at which the soils dried out. Young trees have little foliage with little or no leaf-drop having occurred with the result that the soil below them is very exposed. On the other hand fully mature healthy trees are densely foliated and generally tend to have built up a heavy leaf litter below them. The soil below these trees, therefore, receives little or no direct sunlight.

Soil moisture contents were measured from samples taken below young and mature trees which were fairly close to each other in the same orchards, and available moisture was determined. "Available" moisture was taken as mm of water in the soil below 1,0 bars. Measurements were done prior to irrigations being applied. Results are shown in Table 1.

TABLE 1: "Available" soil moisture under different sized trees

Orchard	Tree Maturity	Available moisture — mm. water			
		Soil depth mm.			Total mm
		0—300	300—600	600—900	
A*	Young	—3,0	3,9	3,5	4,4
	Intermediate	—3,0	1,6	6,3	4,9
	Mature	24,6	6,0	6,7	37,3
B	Young	—6,2	—1,6		—7,8
	Mature	11,3	8,2		19,5
C	Young	1,6	5,1		6,7
	Mature	22,6	16,0		38,6
D	Young	1,5	5,0		6,5
	Mature	21,5	16,0		37,5
E	Young	4,0	8,5		12,5
	Mature	17,0	13,5		30,5

This orchard was sampleA on the 22nd July. The last heavy rain fell on the 30th April with only an additional 20 mm having fallen after this date. No irrigations had been applied.

Immediately apparent from this table is the greater amount of available water in the soil under the large trees. In all cases the upper 300 mm of soil under the young trees was drier than soil below this depth, whereas under the mature trees where there was a considerable mulch of leaf litter on the soil surface, the upper 300 mm of soil had more available water than the lower depths.

With a mixed planting of mature and young trees in any particular orchard, problems could arise in providing the correct amount of water to all trees to bring the soil up to field capacity. A typical example is shown in Table 2 where moisture contents of the soil were measured below small and large trees 48 hours after an irrigation.

TABLE 2: Effect of irrigation on bringing the soil up to field capacity

Tree maturity	Soil depth — mm	mm of water in excess of 0,1 bar	Total water: mm in excess of 0,1 bar in 0—900 mm
Young	0—300	— 8,6	— 23,2
	300—600	— 8,5	
	600—900	— 6,1	
Mature	0—300	+ 3,5	+ 0,8
	300—600	+ 1,0	
	600—900	— 3,7	

The table shows how the irrigation was inadequate on the young trees where the soil

was considerably drier than under the mature trees. Sufficient water had been applied to the mature trees.

Soil moisture measurements were done below fully mature Fuerte trees on the 9th July and again on the 6th August during which time 108 mm of evaporation had occurred from a Class A pan. The amount of water lost from the various depths was calculated and is shown in Table 3.

TABLE 3: Water loss from the top 900 mm of soil below Fuerte trees in a 28 day period

Soil depth — mm	Amount of water lost: mm
0—150	9,0
150—300	4,2
300—450	2,6
450—600	2,4
600—750	1,2
750—900	0,9
Total	20,3 mm

The greatest amount of water was lost from the upper 150 mm of soil with progressively smaller amounts having been lost from the lower depths. Only 20,3 mm in total was lost from the upper 900 mm of soil which gives a pan factor of 0,19.

Similar studies to the above were done to compare moisture utilization under different conditions of tree growth and pan factor calculations based on the moisture loss in the upper 900 mm of soil. Results are shown in Table 4.

TABLE 4: Calculated pan factors for avocado trees under various situations

Cultivar	Maturity	Mulch situation	Calc. pan factor
Fuerte	Mature	Good leaf mulch	0,20
Fuerte	Mature	Tree skirted — limited mulch	0,43
Fuerte	Young	No mulch	0,63
Edranol	Mature	Good leaf mulch	0,40

The pan factors for the young open Fuerte trees are considerably higher than for the mature Fuerte trees based on water loss from the top 900 mm of soil. Skirting resulted in the trees being more open with less leaf mulch below them and a consequent greater loss of water compared with the mature trees.

(c) Effect of plastic mulch on moisture conservation under young trees

In an effort to reduce the water loss below young trees, plastic mulch was placed below young trees (6 months old) and moisture loss compared with trees without the mulch. Moisture loss was compared in the upper 22 cm of soil where it was found that under plastic there was 23,8% less moisture lost than where no plastic was used.

DISCUSSION AND CONCLUSIONS

These studies indicate a very low apparent utilization of water by mature Fuerte avocado trees which have developed a good leaf mulch below them. However, these studies were only done in the 0 - 900 mm soil zone and Fig. 1 shows that the root system extends well below 900 mm. These roots at the lower depths could, therefore, be playing a significant role in moisture extraction. The pan factors calculated for mature Fuerte trees are extremely low when compared with figures of 0,55 - 0,6 by the Israeli findings (Lahav personal communication). However, when mature avocados are irrigated according to a pan factor of 0,2 on HL Hall & Sons, there has been no apparent stress on the trees. Growers should, therefore, exercise caution and check soil moisture content before irrigating as there could be a tendency to apply water when it is not needed.

Soil below young open trees tends to dry out considerably more quickly than that below mature trees. This obviously gives rise to problems when irrigating orchards with trees of different ages. This problem can be partially off-set by applying a mulch to the younger trees. Trials indicated that 23% less water was lost below young trees with plastic mulch. An organic mulch of sorts could be preferable to plastic as the decomposing material results in the build-up of an active microbial population which is detrimental to *Phytophthora cinnamomi.* However, such organic mulches should be applied at the beginning of the winter months to allow time for them to decompose prior to the onset of the summer rains (Wolstenholme personal communication). Mulches such as sawdust do not readily decompose and should be avoided.

Skirting results in the trees being more open, less leaf litter seems to accumulate below the tree and more of the soil is exposed to the sun. This results in the soils drying out more quickly.

If pan factors of 0,2 are used for unskirted mature Fuerte trees with a good leaf mulch and a factor of 0,6 is used for young trees and an effective 50 mm of water is applied at each irrigation, then the frequency at which trees need to be irrigated in the dry months from March to October, assuming that no rain falls during this time, is shown in Table 5.

Table 5 shows that well-grown Fuerte trees need only be irrigated 3 times during the course of the dry season with the cycle between irrigations varying from 60 to 77 days.

TABLE 5: Frequency of irrigations required on young and mature Fuerte trees

Pan Factor	Month	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
	Average pan evap — mm	130	97	100	100	95	130	140	160
0,20	Irrig. times			x		x		x	
	Cycle — days	68			77		60		
0,60	Irrig. times	x	x	x	x x	x	x	x x	x x
	Cycle — days	20	22	26	25 25	27 22	20	18	16

It has been shown that different situations markedly affect the extent to which water is lost from below avocado trees. Where water is a limiting factor certain cultural practices can result in a considerable saving of water. The deep root system of the avocado enables the mature tree to withstand dry conditions for a considerable period of time before showing signs of stress. After a dry summer it is possible that the sub-soils might hold insufficient water for irrigation as infrequently as has been indicated. Soil moisture should, therefore, be monitored directly, either by feel or by the use of tensiometers.