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SOIL DEPTH: THE THIRD DIMENSION

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ABSTRACT

Routine chemical soil analysis data (0-15 cm and 15-30 cm) from the Westfalia Estate, were evaluated for the 1987 season. Similar data, in 10 cm increments to 60 cm, from two representative profiles in established avocado orchards, emphasised the desirability of taking profile conditions into account. The importance of regarding soil as a volume rather than an area by taking soil depth, the 'third dimension', into account, is clearly illustrated.

OORSIG

Roetine chemiese grondontledingsdata (0-15 cm en 15-30 cm) vanaf Westfalia Landgoed, is vir die 1987-seisoen evalueer. Soortgelyke data, in 10 cm inkremente tot 60 cm, vir twee verteenwoordigende profiele in gevestigde avokadoboorde, net die wenslikheid van inagneming van profieltoestande beklemtoon. Die belangrikheid om grond as 'n volume eerder as 'n oppervlakte tebeskou, deur inagneming van gronddiepte, die 'derde dimensie', word duidelik aangetoon.

INTRODUCTION

Soil is very often viewed in terms of area : size of a farm, area under avocados, lands suitable for ploughing or for grazing. Depth is sometimes considered where soil profiles are studied for purposes of mapping and classification, but unfortunately, all too often, soil Is considered in two dimensions. The purpose of this paper is to focus attention on this problem and, through data obtained from avocado orchards, to indicate its limitations and dangers. Soil, by rights, needs to be considered as a volume, or perhaps as layers of volumes, often differing markedly with depth. It is here that the third dimension, namely soil depth, plays a vital role.

Cultivation, soil utilisation, results in important and often dramatic changes in profile conditions. Man changes soil, and it is on some of these changes that take place, and their implications for the utilisation of soil as a medium of growth for plants, that this paper concentrates.

When soil samples are taken for chemical analysis, there is a tendency to concentrate on topsoil. There is often, in this approach, an almost tacit assumption that this is sufficient and that it represents the situation deeper down in the profile. This assumption is, however, not always justified.

Soil scientists involved in avocado production and nutrition have realised the importance of the subsoil. Fouché (1985), for example, analysed at 0-15 cm and 15-30 cm depths, while Du Plessis and Koen (1987) gave soil analysis data for 0-30 cm and 30-60 cm. At a workshop on soil acidity / liming for avocados, held at Nelspruit during October 1986, the soil science group identified the following as a priority: 'Aangesien dit belangrik is om grond diep genoeg te neutrallseer, behoort grondmonsters op die volgende dieptes vir moniteringsdoeleindes geneem te word : 0-15 cm; 15-30 cm; 30-60 cm'.

On the strength of this, it was decided to at least differentiate samples taken for routine analysis at Westfalia Estate. For the 1987 samples, sampling depth was 0-15 cm and 15-30 cm, instead of the 0-30 cm previously employed.

MATERIAL AND METHODS

Commercial soil analysis values, as carried out by the Northern Transvaal Cooperative Laboratories for Westfalia Estate, were grouped and evaluated for the 1987 season, for 0-15 cm and 1530 cm respectively. For this purpose, four areas of the estate were selected, and designated A-D.

As there were considerable differences between the two layers in some cases, it was considered advisable to investigate the soil profile deeper down. To this end, three profiles, representing fairly typical soil situations at Westfalia, were sampled in bulk in 10 cm layers, to 60 cm. These were analysed according to standard methods (Bray and Kurtz, 1945; FSSA, 1980 and Van Vuuren, 1979). Only two of these are discussed in this paper.

This soil was also used to pack asbestos columns, 10 cm in diameter, with 10 cm depths of soil as it was removed ¡n the field. These will be utilised for leaching experiments, in an effort to simulate, and subsequently forecast, changes in depth that are likely to occur under various conditions (acidification and amelioration). This work is in progress and is not reported on in this paper. Most of these results were interpreted to indicate large differences and tendencies, and formal statistical analyses were not carried out.

RESULTS AND DISCUSSION

Routine 1987 soil samples

The top (0-15 cm) and subsoil (15-30 cm) layer samples differed markedly from each other in several chemical respects. Data were grouped according to area (A-D). Averages of chemical analysis values for these areas were calculated, to obtain a general impression. This is obviously open to some criticism, as localised areas of variation may be masked and It Is largely individual situations that need to be evaluated. Data for the different elements are shown in Table 1.

From the above it is clear that, especially in some areas, the second layer is much lower in nutritional elements and pH.

Subsoil relative to topsoil composition

In addition to the above grouping, the percentages of the second layer to the first layer were calculated for individual samplings, and a distribution of relative occurrence made. The data are shown in Table 2.

From these data it is clear that in some areas there are relatively few problems at this level, whereas in others (Area A, for example) this is fairly widespread. It is on these areas that more attention should be focused.

Profile composition

Chemical analysis data relating to 10 cm increments, down to 60 cm, and taken from two representative profiles, are shown in Table 3.

TABLE 1 Average values for topsoil (0-15 cm) and subsoil (15-30 cm) samples from different areas

Area	Sample depth cms	pH	P (Bray I) (mg/kg^{-1})	Ca	Mg	K
				(NH_4-Acetate Extractable) (mg/kg^{-1})		
A	0-15	6,05	11,1	1246	232	82
	15-30	5,40	3,8	438	117	39
B	0-15	6,25	34,6	1356	245	126
	15-30	5,85	20,4	788	208	96
C	0-15	6,45	10,1	1213	223	99
	15-30	6,35	6,1	995	201	89
D	0-15	6,25	15,2	1198	211	91
	15-30	6,00	8,2	778	187	74

TABLE 2 Subsoil (15-30 cm) relative to topsoil (0-15 cm)

Area	Subsoil content as % of topsoil content	pH	% Occurrence				CEC
			P	Ca	Mg	K	
A	<20	3,6	13,8	6,9	0	3,3	0
	21-40		41,4	69,0	23,1	3,3	0
	41-60		24,1	20,7	46,2	60,0	0
	61-80		7,4	3,4	30,8	30,0	11,5
	81-100	96,4	13,8	0	0	3,3	88,5
B	<20		10,0	0	0	0	3,2
	21-40		16,7	13,3	0	0	0
	41-60	3,3	30,0	36,7	41,4	26,7	3,2
	61-80		13,3	16,7	20,7	36,7	3,2
	81-100	96,7	30,0	33,3	37,9	30,7	90,3
C	<20		2,9	0	0	0	0
	21-40		17,1	0	0	0	0
	41-60	5,6	28,6	16,6	16,7	10,8	0
	61-80		25,7	33,3	30,6	29,7	2,8
	81-100	94,4	25,7	50,0	52,8	59,4	97,2
D	<20		6,3	0	0	0	0
	21-40		31,3	12,5	0	0	0
	41-60		21,9	28,1	10,3	25,0	0
	61-80		12,5	18,8	27,6	34,4	6,3
	81-100	100	34,4	40,6	62,1	40,6	93,8

TABLE 3 Soil analysis : DI (Good)

Sample depth cms	pH	P (Bray II)	Ca (mg/kg^{-1})	Mg (NH$_4$-Acetate Extractable)	K	R (ohms)
0-30 (calculated)	6,00	6,5	968	308	58	
0-15	6,60	9,6	1389	410	71	
15-30 (calculated)	5,40	3,3	547	206	45	
0-10	6,80	11	1583	462	76	800
10-20	6,20	7,5	1000	306	61	1000
20-30	5,00	1,2	371	156	37	1300
30-40	4,70	0,4	322	139	32	1600
40-50	4,75	0,7	323	150	29	1500
50-60	4,80	0,8	279	142	22	1500
0-30 (calculated)	5,13	6,8	545	86	54	
0-15	5,5	11,6	873	154	76	
15-30 (calculated)	4,7	2,0	217	18	31	
0-10	5,80	16	1134	218	98	1400
10-20	4,95	2,3	350	25	33	3400
20-30	4,60	1,9	150	15	30	6200
30-40	4,50	1,6	159	17	13	6000
40-50	4,65	1,2	203	28	21	5500
50-60	4,85	1,0	201	40	13	5100

Profile DI is taken from an established avocado orchard in which production is regarded as satisfactory (above average), whereas profile AI represents one in which production is not what it could, or should, be in fact, an unsatisfactory situation.

Consider, firstly, profile Dl. In Table 3, data are given for the six sample depths in 10 cm increments. Above these values, calculated values are given for what the values would have been had samples been taken at 0-30 cm, or 0-15 cm and 15-30 cm, as has been done for the routine commercial samples.

Comparisons of these different values clearly illustrate the dangers of taking only a topsoil sample. This can, in fact, give a false impression of what the position in the profile actually is. In this case it is clear that below 20 cm, and especially below 30 cm, the soil has acidified to a large extent. Potassium levels are also low. It is clear, therefore, that even in this satisfactory orchard, attention will have to be paid to certain nutritional aspects.

Turning to profile AI, exactly the same procedure was followed. Vast differences in pH and the levels of Ca, Mg and K are evident in the differentiated profile, that are certainly not picked up from a 0-30 cm sample (calculated value). In fact, below 20 cm nutritional conditions are so poor that it is doubtful that any feeder roots could function efficiently. Drastic amelioration is obviously essential to improve these conditions.

CONCLUSIONS AND RECOMMENDATIONS

From the above it is clear that profile characteristics need to be monitored before, and during, cultivation. Profile differentiation can have far-reaching implications regarding the growth of plants. Chemical aspects, with important potential repercussions, were discussed in this paper.

There are lots of other aspects that are important as well, especially those affecting water and air regimes and root penetration, conditions and health. Phase discontinuities within the profile, impaired drainage, crusting, compaction all these aspects should receive the necessary attention for efficient and satisfactory growth and production.

This paper would be incomplete without suggesting methods of handling the chemical aspects discussed above. Leaching experiments have been initiated and it is hoped that information will be obtained on changes that can be expected, and possible problems that can be anticipated and rectified timeously. This work is continuing.

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