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Preliminary results of trials with clonal rootstocks for Hass avocado*

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INTRODUCTION

The presence of *Phytophthora cinnamomi* Rands, lethal for avocado plants grafted onto sexually reproduced rootstocks, is a limiting factor in regions where such cultivation is practised.

Tucuman (Argentina) has not escaped this problem, which in the seventies caused the loss of 50 000 – 70 000 grafted avocado trees. This has made rootstocks tolerant to root rot caused by *Phytophthora* crucial to the development of the avocado industry.

A recently published review by Foguet (1992) deals with rootstocks for avocados and describes results of investigations at the University of California into the behaviour of different varieties, the differences between clonal and sexually reproduced rootstocks and the origin of *Phytophthora*-resistant rootstocks.

This basic material, introduced by the EEAOC from 1978 onwards, was used for rootstock trials after the development of cloning techniques suited to local conditions (Foguet and Alvarez, 1982).

MATERIALS AND METHODS

The rootstocks used in the trials were Duke 7, Duke 6, G 755 (Martin Grande) and Lula. This material was produced by cloning between 1988 and 1989 in the EAOC hothouses by the "ahilamiento" (etiolation) method described by Foguet and Alvarez (1982).

With the exception of the Lula material – a cultivar of which it was not possible to obtain a sufficient number of rooted plants – all the rootstocks rooted readily and were subsequently grafted to Hass. Also grafted, were a sufficient number of Lula plants, grown from seed to form a control group.

The plants were grown in 5-litre containers with adequate substrate and were kept outdoors under medium shading until transplanting.

The trials were done at Sauce Hauacho, department of Famaillá, in Finca Ezcurra, owned by the company Guayal SA.

The plantation is situated on a foothill in non-irrigated undulating terrain, and it was necessary to construct contours and borders to accommodate the plants. The soil is shallow loam, pH 5.5;

Table 1 Percentage of plants affected by* Phytophthora *grouped by degrees on a scale of 0 – 10

ROOTSTOCK	GRADING ON 0 – 10 POINT SCALE										
	0	1	2	3	4	5	6	7	8	9	10
Duke 8 cl**	100	-	-	-	-	-	-	-	-	-	-
Duke 7 cl	93	7	-	-	-	-	-	-	-	-	-
G-755-C cl	100	-	-	-	-	-	-	-	-	-	-
Lula seed SC ***	51	-	7	7	-	-	14	14	-	7	-
Lula seed CC ****	72	-	14	-	-	-	-	7	7	-	-

*O, completely healthy plant – 10, dead plant

** cl, clonal

*** SC, without *Phytophthora* control

**** CC, with *Phytophthora* control

Table 2 Production, foliage mass volume and productive efficiency of 5-year-old Hass avocado trees

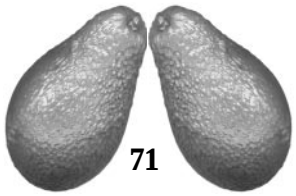
ROOTSTOCK	KG X PLANT					Foliage volume, 1995	EFFICIENCY
	1993	1994	1995	Cumulative	Average		
Duke 6 cl *	1.08	10.46	37.02	48.56	16.18	34.25	1.05
Duke 7 cl	12.72	21.54	76.92	111.18	37.06	42.52	1.75
G-755-C cl	2.50	8.10	26.56	37.16	12.38	64.02	0.40
Lula seed SC **	8.74	11.62	32.72	53.08	17.69	37.75	0.90
Lula seed CC ***	11.46	17.78	51.54	80.68	26.92	38.68	1.37
DSL 5%	-	-	-	37.17	-	12.38	0.78
DSL 1%	-	-	-	45.71	-	17.05	1.08

*cl: clonal

**SC: without *Phytophthora* control

*** CC: with *Phytophthora* control

√ Calculated on production and foliage volume 1995



organic matter, 5,56%; phosphorus low (32 ppm). Annual rainfall, 1500 mm, mainly in October to April.
Planting was done in 1990, at spacing 8 m x 8 m. The planting holes were pre-fertilised with 500 g of calcium triple superphosphate. Experimental design was random blocks, with 5 replications and 3 plants per plot.

The rootstocks were as follows: Duke 6 clonal, Duke 7 clonal, G 755C clonal, Lula seedlings without control and Lula seedlings with *Phytophthora* control. It should be explained that with the exception of treatment No. 4 (Lula seedlings without control) all the other treatments received applications of 30% fosetyl-Al (Aliette) with painting of the trunk for the first 3 years followed by injections of phosphorous acid 1 or 2 times per annum, using the method developed by Darvas (1994).

The main purpose of the trial was thus not so much to determine the degree of resistance to *Phytophthora* – already sufficiently investigated (Menge *et al.*, 1992) – as to assess the performance under local conditions of the clonal rootstocks showing a tolerance of the disease: development, production, fruit quality, insofar as these were unaffected by *Phytophthora*.

PRELIMINARY FINDINGS

The plants were inspected annually for external signs of *Phytophthora* assessed on a 0 – 10 scale used in South Africa (Anon.), with 0 corresponding to a completely healthy plant and 10 to a dead plant. Every other year the average height and diameter of the foliage mass, and the average diameter of the trunk, were measured.

Fruit production was recorded in the form of the number of fruits per tree and weight of fruit in kg per tree; this was found to be an average of 15 fruits per plot or 75 fruits per treatment. In the laboratory the fruits were ripened and their average weight, length and diameter determined, together with the weight, length and diameter of the pit, pulp yield and oil content by Soxhlet extraction.

The average height and diameter of the trees were related to the volume of the foliage mass using the formula $\{(2/3) \P r^2\}$ .h. The fruit production data, foliage mass volume and characteristics of the fruits were analysed statistically using the lease significant difference test.

The condition of the trees in relation to the disease was in general good, with the exception of the plants grafted onto the Lula rootstocks, especially the group without *Phytophthora* control, in which 49% of the trees showed some degree of infection (Table 1). It should however be stressed that all the diseased plants are in a low-lying sector which for reasons physical relief receives water from other areas.

The trees grafted onto G 755 C were the largest in the trial, attaining an average foliage volume of 64 m^3, foliage mass height 5.15 m, foliage mass diameter 4.82 m; at 5 years the foliage occupied practically all the space between the trees. The performance of the remaining rootstocks was fairly uniform, including the plants grafted onto Lula seedling rootstocks without *Phytophthora* control (Table 2).

The rootstocks influenced the productivity of the Hass trees (Table 2). Duke 7 did particularly well both as regards yield in kg and as regards productive efficiency (kg/m^3 of foliage mass), agreeing with results obtained in California and in South Africa (Arpaia *et al.*, 1992; Köhne, 1992) and confirming its good adaptability to different environments and soil types.

G 755 C, in spite of the magnificent development imparted to the trees, has thus far failed to translate into satisfactory production; in fact total production was less good than that obtained with the Lula rootstocks without *Phytophthora* control in the tree harvests studied.

Table 3 Physical and chemical characteristics of Hass Fruit produced on different rootstocks. 1995.

ROOTSTOCK	FRUIT						SEED		
	Weight g	Length mm	Diameter mm	L/D	Pulp %	Oil %	Weight g	Length mm	Diameter mm
Duke 6 cl *	277.55	109.59	74.18	1.47	81.24	19.21	52.01	46.27	42.55
Duke 7 cl	273.33	108.53	73.85	1.46	79.35	19.13	56.38	45.20	42.98
G-755-C cl	272.88	109.15	73.49	1.48	82.00	18.44	49.10	45.28	40.92
Lula seed SC **	260.44	110.87	70.85	11.56	84.11	21.48	41.77	44.70	38.20
Lula seed CC ***	261.55	110.77	72.29	1.52	82.00	19.23	46.99	45.94	40.21
DLS 5%	NS	NS	NS	0.05	1.42	1.99	-	-	-
DLS 1%	NS	NS	NS	0.08	1.94	2.74	-	-	-

*cl: clonal

**SC: without *Phytophthora* control

***CC: with *Phytophthora* control

Table 4 Distribution according to sizes and exportable boxes / hectare of Hass on different rootstocks. 1995 harvest.

ROOTSTOCK	% SIZES 12 - 18	% SIZES bigger than 18	No. of boxes of sizes 12 – 18 per hectare
Suke 6 cl *	85	15	1180
Duke 7 cl	79	21	2278
G-755-C cl	90	10	895
Lula seed SC**	71	29	870
Lula seed CC ***	71	29	1371

*cl: clonal

**SC: without *Phytophthora* control

***CC: with *Phytophthora* control

√ 4 kg boxes

Duke 6, though producing good foliage volume, did not prove productive either.

The plants grown on Lula rootstocks with heavy *Phytophthora* stress but with control treatment were very similar in productivity to the Duke 7 material. Lula has been the standard rootstock in Tucuman, although some Hass/Lula plants in the commercial plantations at Jujuy showed symptoms of incompatibility (Darvas, 1994, pers. comm.). These problems have thus far not been detected in the present study.

In view of the planting density (150 trees/hectare), and the lack of supplementary irrigation, the productivity figures per hectare – of 11,5 tons for Hass/Duke 7 clonal and 7,7 tons for Hass/Lula with Phytophthora control – were commercially very significant.

Table 3 shows the fruit analysis results. The seed rootstocks (Lula) produced slightly smaller fruits than the clonal rootstocks, but he difference was not significant. The shape of the fruit did, however, show significant differences. The Hass fruits grown on clonal rootstocks were narrower or less pear-shaped than the fruits grown on Lula. This influence of the rootstock on the length/diameter ratio of the fruit (A/D) has also been observed in South Africa (Köhne, 1992).

The quality of the fruit, expressed in terms of pulp and oil yield, also showed significant differences, favouring Lula without *Phytophthora* control. It is possible that the pathogen is influencing the oil content and the size of the pit.

The size distribution of the total fruits harvested in 1995 (Table 4) reflects the important influence of the rootstocks on commercial production parameters. Duke 7, although giving 13% less fruit of size 12 – 18 than G-755-C, yielded the largest number of boxes of these sizes per hectare – as a consequence of its greater productivity. The data cited in this study should be interpreted with caution, inasmuch as they reflect only 3 harvests, from 5-year old plants. The data do, however, confirm the sometimes economically decisive influence of rootstocks.

LITERATURE CITED

ANON. Ciba-Geigy. Effective root rot control in avocado trees with Ridomil 5G.

ARPAIA. M.L., BENDER, G.S. and WITNEY, G.W. 1992. Avocado clonal rootstocks production trial. Proc. *Second World Avocado Congress*, 305-310.

DARVAS J.M., 1994. Control of Phytophthora-induced root rot in avocado trees by means of injections into the trunk. *Avance Agroindustrial*, 59: 41.

FOGUET, J.L. and S. ALVAREZ, 1982. Rooting of avocado cuttings by the 'ahilamiento' (etiolation) method. *Revista Industrial y Agricola de Tucuman* 59 (1-2): 151-55.

FOGUET, J.L., 1992. Rootstocks for avocados. *Avance Agroindustrial* No. 48 pp. 3–6.

KöHNE, J.S. 1992. Field evaluation of Hass avocado grown on Duke 7, G6 and G755-C rootstocks. Proc. *Second World Avocado Congress*, 310-303.

MENGE, J.A., GUILLEMET, S, CAMPBELL, S., JOHNSON, E. and POND. 1992. The performance of rootstocks tolerant to root rot caused by *Phytophthora cinamomi* under field conditions in Southern California. *Proc. Second World Avocado Congress*, 53-59.