ROOTSTOCK EFFECT ON AVOCADO VIGOR AND PRODUCTIVITY*

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Abstract

In long-term,large-scale avocado rootstock-scion research, the effect of rootstock on tree vigor and size was evaluated. Tree size was calculated from aerial photography as the projected area of the canopies. This method also enabled yield per unit land area to be calculated. In some cases, the trunk circumference was measured and correlated with the canopy projected area. During 1972-1990, about 150,000 trees, involved in about 700 field experiments, were measured by this method. As a result of this follow-up, it can be concluded, that avocado rootstock affect tree vigor and size to a considerable and significant extent. From the economical point of view, the reduction of tree size could result in either increased or decreased yield per unit area. Furthermore, the, dwarfing rootstocks selected in this research are restricted to certain combinations of soil factors, like any other rootstock, and could not be recommended for use everywhere.

1. Introduction

Avocado (Persea americana Mill) is a vigorous evergreen tree, which became a commercial crop just a few decades ago. The large size of the trees of most commercial cultivars causes excessive expenses, especially for labor and fuel, and overcrowding of the orchard. Soil destruction is a secondary result. Dwarfing rootstock is considered the best means to control the size of fruit trees. In avocado, there is limited information regarding this subject. Ben-Ya'acov (1987) concluded, that "rootstock affect tree size to a large extent, and thereby can also affect the productivity per unit area". In a study on avocado rootstock-scion relationships, the subject of the effect of rootstock on tree growth was included, and the effect was related to productivity. The aim of this project is to find the best rootstock-scion combinations, for each cultivar and for various growth conditions. The main problems that demand solution are soil problems, such as salinity, lack of aeration, lime-induced chlorosis and soil diseases, and problems of productivity and tree size.

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2. Methods

A large-scale, long-term field-research system was established; it involves the evaluation of about 400 seeded rootstocks, and 160 clonal rootstocks, in about 700 field experiments, planted in commercial orchards in Israel (Ben-Ya'acov, 1972). About 180,000 trees were studied in the experiments. The preferred method of evaluation of tree size was by measuring the projected canopy area. A set of calibrated rings was used to measure the trees, which had been photographed from the air. These measurements were found to be highly correlated with measurements in the field (Kadman, et. al, 1976). This method facilitates calculation of productivity per unit area occupied by the tree.

3. Results

Representative results are shown in Tables 1-3. At Horshim, four rootstocks were compared for Hass cultivar (Table 1). Of those, Zofit 2 produced high yield, but equal to that on Benjamina rootstock. However, trees grafted on Benjamina were found to be smaller in size, as measured by aerial photography, so that the efficiency, calculated as yield per unit area, was significantly better on this rootstock.

For Fuerte cultivar, data are presented from an experiment at Ma'agan Michael orchard (Table 2). Acre rootstock produced significantly less than Degania 117, in terms of yield per tree, but its trees were smaller and the yield per unit area was found to be the same. Smaller trees are to be preferred, if yields per unit area are equal. The third rootstock in this experiment - Ashdot 19 - developed the largest trees, which produced the lowest yield. Thus, the efficiency of this rootstock, in terms of yield per unit area, was very low.

The third experiment (Table 3) was planted also at Ma'agan Michael, the cultivar under evaluation was Ettinger. Here, the least productive rootstock - Mekler - was found to be the most efficient, when evaluated in terms of yield per unit area, because the area occupied by each tree was significantly smaller.

Similar data were obtained in many of the experiments in the system. Moreover, some rootstocks, especially those belonging to the "Nachlat", West-Indian group, have a consistantly dwarfing effect on the grafted tree, measured by any index.

The mechanism responsible for dwarfing by rootstock in avocado is not known, and was not studied deeply in this research. In some cases the "inverted bottle" phenomenon occured, in connection with the dwarfing effect. A case like this is shown in Fig. 1 and Table 4.

4. Discussion

Control of tree size in avocado is essential, and could be best achieved by dwarfing rootstocks. Other means of control, such as pruning or selection of dwarfing cultivars, are very limited in their benefit. Rootstock affect canopy projection area, tree uprightness and any other vigor index. (Arpaia et al. 1990, Lopez et al. 1987,

Bergh et al. 1988). The order of merit, in regard to productivity, obtained when rootstocks are evaluated according to yield per tree, could change, in many cases, when they are evaluated according to yield per unit projected area. This calculation is important also, when choosing the outstanding trees of a certain population, for clonal duplication.

Dwarfing rootstocks could be found in each of the three horticultural races of the avocado, but they are common among the West-Indian "Nachlat" group.

In addition to the dwarfing mechanism described by Lopez et al. (1987), another phenomenon, the "inverted bottle", has been found and is described above. The two phenomena were not found in every case of dwarfingness.

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Table 1 - Hass avocado cultivar: 10-years accumulated yield and tree size "Horshim" orchard, planted 1976.

Rootstock	No. of trees	Yield* (kg/tree)	Projection area* (m^2)	Yield per unit area* (kg/m^2)
Zofit 2	48	297 A	24.5 A	12.3 B
Benjamina	31	292 A	18.6 C	16.3 A
Shiller 66	47	262 AB	21.3 B	12.5 B
Shiller 27	42	223 B	21.7 B	10.2 C

* Values followed by different letters are significantly different at the P = 0.01 level.

Table 2 - Fuerte avocado cultivar: Accumulated yield until the age 14, and tree size. Ma'agan Michael orchard, planted 1972.

Rootstock	No. of trees	Accumulated yield* (kg/tree)	Projection area* (m^2)	Yield per unit area* (kg/m^2)
Degania 117	30	384 A	35.4 A	11.1 A
Acre	31	324 B	29.4 B	11.4 A
Ashdot 19	14	234 C	36.2 A	6.4 B

* Values followed by different letters are significantly different at the P=0.01 level.

Table 3 - Ettinger avocado cultivar: 9-year accumulated yield and tree size. Ma'agan Michael orchard, planted 1975.

Rootstock	No. of trees	Accumulated yield * (kg/tree)	Projection area* (m^2)	Yield per unit area* kg/m^2
Ashdot 8	46	375 A	25.5 A	16.3 B
Ashdot 5	42	361 A	27.9 A	14.9 B
Mekler	15	318 B	18.5 B	19.8 A

* Values followed by different letters are significantly different at the P=0.01 level.

Table 4 - Circumference of "Horshim" avocado trunk, in a typical dwarfing stionic combination.

	Circumference (cm) August 1991 six years after planting
Scion 1142	47.7
Rootstock VC 68	37.8

Fig. 1: A typical "inverted bottle" phenomena, in avocado: The rootstock size under the graft union is much smaller than the scions