

AVOCADO ROOTSTOCK-SCION RELATIONSHIPS: A LONG-TERM LARGE-SCALE FIELD RESEARCH PROJECT

Preparation of the experimental set-up in the planting of commercial avocado orchards in Israel

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Avocados are generally propagated by grafting commercial varieties on seedling rootstocks. In contrast to many other fruit species, very little is known about rootstock characteristics, their suitability for different soil conditions, or their effect on vegetative growth and the fruitfulness of the tree. Similarly, little is known about the properties of graftwood taken from different sources.

For horticultural reasons the rootstocks preferred in the main avocado-growing countries belong to specific races: Mexican rootstocks are used in California, West Indian stocks in Florida, and Mexican and West Indian stocks in the different regions of Mexico. A gradual change over from Mexican to West Indian types is taking place in Israel due to changes in the quality of irrigation water and the soils planted. In practice, however, the choice of the specific rootstock used in the different countries is governed by the considerations of the nurseryman.

To date very little research has been done on avocado rootstock and graftwood sources. A rootstock trial started in Florida with the varieties Waldin (West Indian), Taylor (Guatemalan) and Topa-topa (Mexican) was stopped before real data could be collected. From experimental plots all over California, set up by Halma in the early 1940s, data were collected over a number of years but only a short preliminary report has so far been published (1). Halma passed away before summing up the results and the data are now being processed and summarized. In California, the main emphasis placed on rootstock work was the search for a *Phytophthora-resistant* stock.

In Israel, Oppenheimer conducted a rootstock trial in light soil with Mexican and Guatemalan stocks. The experiment was summed up (2) and showed that higher yields were obtained on Guatemalan than on Mexican rootstocks, and that the yields were especially high when the Nabal variety was used as stock.

A number of general characteristics of the rootstocks in use are known, particularly how tolerant the various horticultural races are to different soil and climatic conditions. West Indian stocks have been found tolerant to salinity in Israel and Texas, and these types are also tolerant to excess lime in the soil. Mexican stocks are the most sensitive to

salinity, and the Guatemalan ones are the most sensitive to lime. Climatically, the West Indian types which originate in tropical regions are most sensitive to cold, whereas the Mexican types, originating in the uplands, are most tolerant.

In contrast, nearly nothing is known about the influence stocks have on the fruitfulness or the general development of the trees.

The trial described below was started in 1967. The following points had to be considered when setting out to investigate the influence the rootstock and source of the graftwood has on tree development and fruitfulness:

1. The scarcity of information about the subject.
2. The large number of sources for propagation material found in Israel.
3. The need for stock-scion combinations which are suitable for very different conditions of soil and climate.
4. The need to answer many questions in a relatively short period of time.
5. The great variability found in avocado seedlings which are heterozygous.

Taking these points into consideration, a number of principles of experimental method and execution were defined, as described below.

Objective of the Project

The objective of the project is to find and define the most successful combination of stock and scion from the point of view of fruitfulness, fruit quality, tree development and resistance to detrimental factors, for each set of climatic and soil conditions and for each commercial variety.

Principles of the Operation

To answer all the problems set, a large-scale field trial was planned. It is based on planning and establishing a large number of experiments to compare rootstock and graftwood sources of different varieties under various conditions. The execution was incorporated in the work of commercial nurseries and in the establishment of commercial orchards. In planning a plot, the cultivars desired by the grower were included, but within each cultivar an experimental design was laid out in keeping to the principles of distribution, replication and randomization of the rootstock-scion combinations to be compared. Another principle of the operation was not to bother the grower with the special practices required for an experiment. The grower carried out his usual practices, but the marking of saplings for the experiment, distributing them in the field according to the planned blocks, making maps, and collecting data were performed by the research team. Another principle followed was that to keep the different plots comparable, some combinations were included in different experiments.

An experiment on such a large scale, involving the cooperation of so many nurserymen and growers, might well suffer in accuracy. This was taken into account and the principle of "quantity overriding quality" was adopted in this case. The general extent of

the trial is very large and the number of representatives of each combination found in each experiment is adequate. During the early years of the trial, the results will be used to reject only those rootstocks which prove very sensitive to soil or other conditions. Subsequently, stocks or sources of graftwood which bring trees into bearing late will be rejected. At a much later stage, the best combinations of stock and source of graftwood for each variety will be chosen from those left after earlier selections.

Methods Used in the Trial

A large wave of avocado planting took place in Israel during 1968 and 1969 and most of the plots in the trial were established during this period. Practically, the work included the following stages:

1. Information about growers' planting plans and about the availability of propagating material in the nurseries was collected.
2. Joining the trial was suggested to all growers who intended planting, and they were asked to fill in detailed questionnaires about their planting plans and sources of plants.
3. All avocado nurseries were contacted and they were requested to produce stock-scion combinations which could later be compared (different sources of graft / woodgrafted on the same stock, and scion-wood from the same source grafted on different stocks). More specific-requests were also made to nurserymen concerning the preparation of plants for one or another of the experiments included in the trial.
4. The nurseries were inspected at regular intervals for: a) Reliability of marking and writing up of data, b) Evaluation of the characteristics of the different stocks from a propagator's point of view and c) Estimation of the number of combinations actually produced, so that the experiments could be planned.
5. Close to the time of planting, maps of the orchards were prepared and the different combinations were marked with different colors on the maps.
6. The plants were marked in the nursery with colored ribbons according to the colors used on the maps.
7. Plants were brought to the orchards and distributed for planting according to their distribution as planned on the maps.
8. After the grower finished planting, maps were brought up to date with any changes which had occurred in the course of the work.

Approximately 2000 dumuns (500 acres) designed for the experiment have been planted to date (mainly in 1968 and 1969). This area includes over 50,000 marked and listed trees. Approximately 200 experiments at 50 different sites are included in the large trial. Approximately 250 different Mexican, West Indian, Guatemalan and hybrid rootstocks are being compared as well as a similar number of graftwood sources.

The planted experimental plots are under constant observation and surveys of tree development and trunk measurements are being made. Since it is impossible to follow up in detail all the plots, observations are conducted in plots with salinity problems or chlorosis whereas measurements are made in plots of more general interest. Aerial

photography is used to follow up the state of development of trees in all plots.

Data on yields will of course be collected. This will be possible since growers generally record the yields from every tree individually. All data will be processed and analyzed by computer.

Preliminary Results

Surveys of the young orchards have already brought to light different effects of the rootstock on tree development and sensitivity to salinity and lime. In spite of the fact that these data are only preliminary, a number of sensitive rootstocks have been eliminated from subsequent plantings under similar conditions. An example of degeneration and death caused by the rootstock is the case of 'Degania 9'. Most Hass trees planted on this stock in two very different and also distant areas, the Jordan Valley and the Negev, degenerated and subsequently died. Two cultivars, when used as stocks, have so far proved very sensitive to lime-induced chlorosis: Nabal (which was previously known) and the Florida cultivar 'Booth 8'. A number of types accepted as West Indian by the nursery trade have also been found to be very prone to chlorosis. Their use has therefore been stopped. Rootstocks which are either very sensitive to or very tolerant of lime, such as Nabal seedlings and certain West Indian types, respectively, express these properties under a very wide range of conditions. Other types, however, which are intermediate in sensitivity, e.g. various Mexican stocks, Lula stocks and certain West Indian types, show different relative sensitivity under different conditions. It seems that sensitivity does not depend only on the total lime content of the soil but also on the type of lime as well as other soil factors such as texture.

The effect of horticultural race on salt sensitivity is more specific. Damage is generally found only in trees worked on Mexican stocks, whereas those on West Indian and Guatemalan types are sufficiently tolerant for the salinity of water generally used for irrigating avocados in Israel (up to 250 ppm cl). As a result of data collected in the experimental plots, the use of stocks of the Florida cultivar Fuchs has been suspended. It was found to be more sensitive to salt than other West Indian and Guatemalan cultivars and types.

Summary and Conclusions

A large-scale field trial has been set up in conjunction with commercial plantings in all the avocado-growing regions in Israel. The objective of the trial is to study the effects both rootstocks and the source of graftwood have on trees development and fruitfulness and tolerance to various environmental conditions. A very large number of experiments were planned and planted within the framework of the overall trial. These may well give answers to the specific problems arising in each growing area and each cultivar. Early observation of tree development in the experimental plots has already made possible the elimination of a number of rootstocks from the nurseryman's list following the recognition of their detrimental effects on tree development.

Results of observations carried out in fruit-bearing orchards (A. Ben Ya'acov, unpublished data) show that significant differences may be found between different

rootstocks even when they originate from a very variable seedling population. This fact has encouraged us to continue the follow-up in the planned orchards as described above, in spite of the fact that the problem of the variability of the rootstocks used might detract from the success of the experiment.

REFERENCES

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2. Oppenheimer, Ch. (1959) Avocado rootstock and varieties experiment. Ktavim 9 (3-4): 247-256. (in Hebrew)