

A REVIEW OF EXPERIMENTS ON SOME FACTORS INFLUENCING THE ROOTING OF AVOCADO CUTTINGS

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In avocado fruit a single embryo is formed in each seed, thus only one seedling grows from each seed sown. Due to the almost universal cross pollination in this species, the embryo results from fertilization of the egg cell by the sperm cell of an unknown male parent.

Since, in addition, all avocado varieties are highly heterozygous, both egg cells and pollen grains are of an unknown genetic constitution and practically every one is different from all others.

It is impossible, therefore, to produce genetically uniform planting material from seed. Avocado seeds, even if taken from a single tree for the purpose of rootstock production, will produce a population of seedlings with more or less widely different characters.

Naturally, if seeds are taken indiscriminately from different trees, this non-uniformity will be even greater.

The achievement of uniformity in rootstock characters is of considerable importance, in at least some cases, for the success of an avocado orchard. Two examples may be cited: the reaction of the rootstock to high lime content, and salinity of soil and irrigation water; and the reaction to soil-borne diseases, such as *Phytophthora cinnamomi*.

At present it is possible to find both trees which are suffering greatly from salinity and others which show only little or no damage in one and the same orchard. This phenomenon can be attributed at least partly to the inherent differences among the rootstocks.

The only way in which complete genetic uniformity of avocado rootstocks can be achieved is by vegetative propagation. Experiments on the vegetative propagation of avocado rootstocks have been carried out for several years in the Division of Subtropical Horticulture of the Volcani Institute of Agricultural Research. Much effort has been devoted to this research and some valuable results have been achieved, although no commercial method of vegetative propagation of avocado rootstocks has yet been found. The experiments are being continued and there is good reason to believe that in the near future a satisfactory-method will be found.

In this paper a short description is given of the experiments which have been carried out to the present. In 1957, experiments to root avocado cuttings under mist spray were

started. Another method which was tested was by air-layering of avocado branches, but this resulted in very little success. Later it was found that the only method which could be considered for the rooting of avocado cuttings is with the use of an artificial mist spray.

The first experiments carried out with avocado cuttings were of a preliminary nature. Many questions had to be answered. What is the best type of cutting to be rooted; which is the best season; is there any need for pretreatment such as with plant hormones, and, if yes, which hormones are to be used, and in what form and concentration; what is the best rooting media; what is the optimum temperature of the substrate, etc.?

Naturally, in the early experiments it was necessary to use a great number of treatments and thus only a small number of replications could be used for each treatment. This eliminated the possibility of obtaining clear-cut conclusions, but enabled us to obtain indications as to the better treatments.

During the second stage of experiments, the number of treatments was sharply reduced to only the most promising ones, and the number of replicates was greatly increased.

In the first part of this paper the various treatments used (according to treatment groups) will be noted without going into details or statistical analysis. In the second part, the most promising treatments and the aims of future experiments will be pointed out.

Factors connected with the mother tree from which cuttings were taken:

1. Effect of type of the mother tree: Cuttings from many different types were tried, mostly from seedling trees and some from grafted trees.
2. Effect of age of the mother tree: Cuttings were taken from trees of different ages, from very young (2-3 months) to 20 years old.

Factors connected with the type of cuttings and the seasons:

3. The rooting capacity of various types of cuttings were tested: Terminal, sub-terminal and basal cuttings (the basal part which is connected to the branch). Soft, semi-hard and hard wood cuttings. Short cuttings (5-8 cm) with 4-5 leaves, and long cuttings (12-15 cm) with 8-10 leaves were used. Cuttings grown from buds underneath the soil with etiolated bases were also tested.
4. Effect of the season in which cuttings are taken: The four different seasons were tried.

External factors and some supplementary treatments:

5. Effect of treatment with plant hormones: The effect of various synthetic hormones was tested. Indolbutyric acid (IBA), Naphthaleneacetic acid (N.A.A.), and others were used in different forms and concentrations. Quick dipping of the cutting base in concentrated (10,000 ppm) solution, or long dipping in diluted solution. Hormones in

the form of powder mixed with talc were also used.

6. Effect of rooting media: Various substrates were tested as a rooting media: Vermiculite dune sand, fine gravel, and other materials pure and mixed.
7. Effect of light intensity: Different light intensities were examined to determine the optimum light needed for rooting of avocado cuttings.
8. Effect of type and duration of mist spray: Various types of nozzles for mist spray, and various spray durations and intervals, such as constant spray or intermittent spray, with different intervals and different amounts of water, were tested.
9. Effect of temperature of the rooting media: The influence of heating the rooting media by means of an electric cable during the winter and early spring was examined.
10. Effect of removal of complete or half leaves: Various treatments of removal of entire leaves or parts of them from the cutting were examined.
11. Effect of pre-etiolation of the cutting base: The bases of the cuttings were protected from light while still attached to the mother plant and as a result they remained etiolated. This method, used in California, was tried here with some variations.

Combination of different treatments:

Many experiments were devoted to studying the combined effect of various treatments, such as the source of cuttings, their types, season, etc., under different treatments of hormones and rooting media, or different light and temperature conditions.

OBSERVATIONS AND DISCUSSION

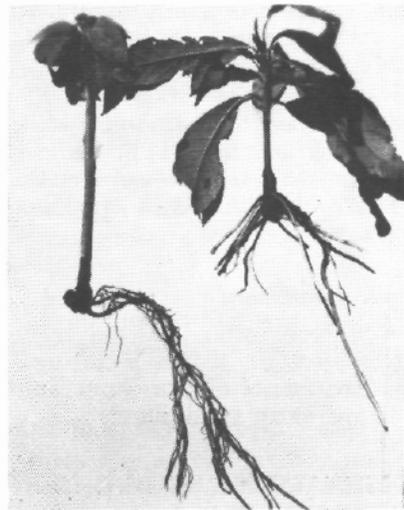
Avocado cuttings inserted under mist spray develop a layer of callus on their bases within a few weeks. After some time this callus may reach a considerable size and develop different forms. No connection was found, however, between the formation of callus and the rooting of the cuttings. In general it takes about three to four months before root initiations can be observed (seldom ever are roots found after three to four weeks). Usually the roots penetrate through the callus, but sometimes the roots appear while there is no callus development on the cutting. After initiation the roots usually develop well, and are fairly thick and well distributed. In many cases, however, the secondary roots branch from a single initial root.

In the study of some factors influencing the rooting of avocado cuttings, the following was found.

1. The characteristics of the mother plant: This seems to be the most important factor in succeeding to root avocado cuttings. Rooting percentages ranging from 0-100% have been obtained from different types under the same conditions. Among the three horticultural races of avocado, certain types of the Mexican and Guatemalan races showed high rate of rooting, although many other types did not root at all. Most types of the West Indian race are very difficult to root. Cuttings taken from

adult seedling trees of the West Indian varieties, Lula, Fuchsia and Hall did, however, root in our experiments.

2. Age of the mother tree: It was found that the greater the age of the mother tree from which cuttings were taken, the lower was the percentage of rooting obtained. Even cuttings from most West Indian types, which usually could not be rooted when taken from an adult tree, did root when taken from very young seedlings. This, however, has no practical value for the propagation of rootstocks as these types could not be tested quickly enough.



Rooted avocado cuttings. At right, well distributed roots. At left, single initial root.

3. Type of cuttings: Conflicting results have been obtained with respect to the type of cuttings. Soft, grassy cuttings usually rooted faster than semi-hardwood cuttings, but since soft cuttings are very delicate, they are much more subject to attack by various fungus diseases than are harder cuttings, so that in the end more rooted cuttings have been obtained from semi-hardwood cuttings. Terminal cuttings usually rooted better than sub-terminal or basal cuttings.
4. Season of rooting: In Israel it is possible to obtain good results during the spring, summer or early fall. Without bottom heating facilities, no rooting was obtained during the winter; and cuttings taken during the winter were in very poor condition in the spring.

It is therefore better, under normal conditions, to take the cuttings in the spring so that they will root during the summer and then be in good condition for transplanting. If, however, additional heat was supplied artificially to the rooting media, the cuttings rooted fairly well during the winter season, and could then be transplanted in the spring.

5. Effect of plant hormones: The plant hormones which were tested (mainly IBA and NAA) did not affect the rate of rooting of the cuttings. They did, however, improve

the development of the root system; there was no difference in this respect among the various hormones.

In a preliminary test a positive effect was obtained by dipping the basal edge of the cutting in a humus extract solution prior to its insertion into the rooting media.

6. Rooting media: In most of our experiments coarse vermiculite (No. 4-5) was used successfully as a rooting medium. When dune sand or fine gravel was used a lower percentage of rooting was obtained.
7. Light intensity: By reducing the natural sunlight to half its intensity (a saran screen of 50% shade was used to cover the top of the rooting construction), more and better rooting was obtained than under full sunlight. This shade also reduced the infection of the cuttings by various algae, and reduced leaf burn.
8. Type and length of spray: An intermittent spray, at a rate of four to six seconds in a one-minute cycle, was found to be far superior to a constant spray. No spray was given during night.
9. Heating of the rooting media: Heat was supplied to the substrate during the winter season. When the bottom was heated up to 25-30 degrees C. (77-86 degrees F.), the cuttings in most cases rooted better or faster in comparison to the unheated treatments, where the temperature was around 10-15 degrees C. (50-59 degrees F.).

In our experiments we have found three groups of avocado cuttings which differ in their reaction towards bottom heating: (a) With some Mexican types the rooting time was greatly shortened (three months instead of six to seven months), but there was no difference in the final percentage of rooted cuttings, (b) In some Guatemalan types or crosses between Guatemalan and West Indian (Lula), bottom heating increased the rate and decreased the time of rooting, (c) Some West Indian types could be rooted only with the use of bottom heating, and never rooted without it.

10. Removal of entire leaves or parts of them: No advantage could be found to the removal of either half or entire leaves compared to no removal of leaves from the cuttings. The leaves close to the basal part of the cutting are usually removed before the cutting is inserted into the rooting media.

In no case, however, should all leaves be removed from the cuttings.

11. Etiolation of the basal part of the cutting: This method showed good results even in the rooting of cuttings from types which did not root under any other treatment. It seems, however, that this method can be used only for experimental purposes and not commercially, due to the small number of cuttings that can be obtained from the mother plant.
12. Combined treatments: It was generally found that a treatment which has given good results by itself, showed good results also when combined with other good treatments.

Finally, it must be pointed out that the results discussed here are of a preliminary nature and by no means cover all the aspects of the rooting of avocado cuttings. Research of a practical, as well as a basic, nature is being continued.

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