The Division of Subtropical Agriculture. The Volcani Institute of Agricultural Research 1960-1969. Section B. Avocado. Pg 47-54.

4. VEGETATIVE PROPAGATION

a. Rooting of Leaf-bearing Cuttings - *A. Kadman* and *A. Ben-Ya'acov*

It is very important to grow genetically uniform rootstocks in the orchards. Because all avocado types are highly heterozygous, it is not possible to obtain genetically uniform material from seeds, even if they are taken from only one tree. By selection between and within populations, suitable types can be obtained for special conditions, such as resistance to salinity or lime. But for all conditions uniform rootstocks are desirable because they will result in greater uniformity within the orchard and, thus, in higher and more uniform productivity.

During the last ten years much work has been carried out, but in spite of this and in spite of some successes, it has not, so far, been possible to work out methods which give the consistently high percentage of rooting needed for commercial production of vegetative stocks. This report gives a survey of the work done and the results obtained so far.

About ten years ago trials were started to root leafy avocado cuttings of many different types under mist spray. Air-layering was also tried for some time, but the lack of positive results led to the termination of this part of the work.

During the first, exploratory part of the work, it was necessary to investigate many factors: type of cutting, season, growth substances, medium, and temperature of medium and air. Thus, very many combinations had to be tried and this could be done only by using rather small numbers of cuttings for each. This gave us valuable hints, but few conclusive results. In the later trials fewer combinations, but with a greater number of cuttings for each, were used.

Below are detailed the factors investigated, followed by some of the results and our plans for future work.

Factors of the mother tree

Type of mother tree: Cuttings were taken from a very great number of different types from the three horticultural races and their hybrids, mostly from seedling trees, but also from a few standard varieties.

Age of mother tree: Cuttings were taken from trees of all ages, from young seedlings to mature trees of 20 years and more. S. Karie, in his M.Sc. thesis, investigated the influence of age of mother trees and started work on the possibility of rejuvenation (see section B. 4.b) through budding on young material.

Factors of the cutting itself

Many types of cuttings were tried: Top, intermediate and basal; semi-hardwood and hardwood; short (up to 8 cm) and long (12-15 cm); from different parts of the mother

tree and from suckers with an etiolated base.

Cuttings were taken in spring, summer and fall. In late fall or winter, cuttings were supplied with bottom heat.

External factors and different treatments

Many different growth hormones, at various concentrations, were used; quick dipping in concentrated solutions *vs.* longer immersion in more diluted solutions, or as powder mixed with talc.

Many mediums were used, including vermiculite, dune sand, coarse sand, plastic foam, peat, perlite and others.

Shading was tried to obtain different light intensities.

Mist spray timing schedules (constant *vs.* intermittent spray), quantities of water, and types of installations were tried such as electric timers and an electronic leaf.

Heating of the medium was tried during the cold season, with different installations.

Leaves were cut completely or partly, and kinetin influence on prevention of leaf abscission was investigated.

Prior etiolation of the base of cuttings (as done with good results in California). The base of the cuttings while still on the mother tree is covered so as to prevent chlorophyll formation. We tried this method with certain modifications.

Girdling of the cutting while still on the mother tree, some time before cutting, should bring about a higher concentration of carbohydrates near the base of the cutting.

In most trials several factors were combined, such as age of mother tree, type of cutting, season, hormone treatments, media, light intensity, bottom heat and others.

Hardening: Work was done on hardening of the rooted cuttings by gradually widening the intervals between mist sprays and in other ways bridging the gap between artificial and natural growth conditions.

Results

Type of mother tree: This was found to be the most important factor in all our work. There are genotypes which consistently gave nearly 100% rooting under practically all conditions, while others did not root at all, or only sporadically and never fully.

Age of mother tree is another factor of great importance. Normally, rooting potential declines with increasing age of the mother tree. S. Karie found this decline in trees of Ettinger and Fuerte between nursery trees and mature trees.

Type of cutting: Top cuttings generally root better than intermediate or basal cuttings. Short basal cuttings gave good results; medium soft cuttings are better than woody, or semi-woody, especially as to time needed for rooting. Etiolated suckers generally gave good results.

Season: Good results can be obtained in all seasons, but bottom heat is needed in late fall and winter. Spring cuttings have the best conditions for growth after rooting.

Growth regulators showed more influence on growth of roots than on rooting

percentage. In most trials no consistent differences were found between different hormones and concentrations, but the potassium salt of indole-butyric acid generally gave good results, in late autumn of 1968 and 1969, both as to percentage of rooted cuttings and time needed for rooting.

Medium: Rough vermiculite was found to be the best material, as to both water-holding capacity and aeration. Perlite and/or peat can be used.

Light intensity: Shade permitting 50% light intensity was superior in summer to full light. Saran nets gave the necessary shade.

Type of spray: Intermittent spray is better than continuous. A 4-6-second spray every minute, regulated by an electric timer, gave good results, but during the hottest days and the hottest hours of such days, somewhat more is necessary. The electronic leaf cannot be relied upon to function successfully under conditions where irrigation water contains too much salt.

Heating of medium to about 25°C in winter generally gave good results, but not all types reacted to it. Heated concrete plates gave good heat distribution.

Cutting of leaves or prevention of leaf drop: Cutting of the leaves altogether resulted in failure. The same was found when leaves dropped from the cuttings by themselves after some time. In order to prevent, or at least delay, leaf drop, kinetin was tried. In West Indian cuttings this treatment delayed leaf drop by 10-14 days. Cutting part of the leaves had no effect on the rooting of the cuttings.

Etiolation of the bases of the cuttings gave very good results even in types which otherwise would not root at all. This method is now in use in one of the nurseries for the preparation of planting material for trial orchards (see section B. 2).

Girdling prior to taking the cuttings had no effect on rooting.

Combinations: It is difficult to point out interactions. In most cases the effects of treatments did not seem to be much modified by others.

Hardening: After rooting, the cuttings have to be gradually brought to grow under normal conditions. This is a very critical period. It has been found best to reduce mist intensity gradually during 7-10 days.

Conclusions

Thousands of cuttings have been rooted, from many tens of types, during the years of this work. Trees from rooted cuttings of the selected types are growing in the mother plots and hundreds of vegetative rootstocks have been planted in trial plots and orchards. However, no solution has yet been found for the two most important problems: How can the time of rooting be shortened? How can conditions be worked out which will give to the commercial nurseryman high and consistent rooting percentages year after year?

The work will have to be continued until these problems are solved. Different methods are being tried — among them "miniature-cuttings" with only one bud, which are grown by tissue culture methods. Work has also been started to find endogenous promoters and inhibitors.

b. Juvenility as Promoter of Rooting of Cuttings — *M. Shafrir*

Leafy avocado cuttings from mature trees fail altogether to root in some types; in others rooting percentage is very low, and even in the easiest cases, rooting takes too long (4-10 months). On the other hand, cuttings from young seedlings (one year or younger) will root at a very high percentage and within 4-12 weeks.

Work has been started at Bet Dagan in order to try to transfer juvenility factors from seeds or young seedlings to cuttings from mature trees by grafting the latter on the former and using the graft — after some time of growth — as a regular cutting under mist spray, or using the seedling as "nurse" for the cutting grafted on to it to get rooting *in situ* without transplanting to mist-spray.

1. In March 1967, four to six-month-old seedlings, mostly Duke, were grafted with eight types from the mother orchard at Bet Dagan. In early winter of 1967, after growth had stopped on most of the grafts, they were pruned to 6-8 cm above the graft union. The cut-off material was used for two purposes: grafting for the second cycle, and rooting as cuttings under mist. At the same time new grafts were made from adult material for a second first cycle. In November 1968, therefore, there were second cycle grafts. From these, using the procedure outlined above, grafts were taken for the third cycle and again as cuttings under mist. The second group went into second cycle and a first cycle was prepared for a third group. In early winter of 1969, cuttings from three cycles will be available. Table B. 4.1 gives the results from the first two cycles.

TABLE B. 4.1

PERCENTAGE OF ROOTING OF CUTTINGS WITH ONE, TWO OR NO JUVENILITY TREATMENTS, WITH (+) AND WITHOUT (−) IBA (10,000 ppm quick dip)

Type / *Number of treatments*	G.A. 13		Fuchs 20		Anaheim–3		Lula–3		Nahlat 10	
	+	−	+	−	+	−	+	−	+	−
0 (control)	46	30	23	10	6	0	5	0	0	0
1	85	60	61	44	26	10	25	8	0	0
2	97	70	76	57	38	22	35	20	60*	0

* Six out of ten.

In October, root initials were seen in the callus of West Indian grafts, while some others already had two to six rootlets of 3-6 cm length. However, the bases of many cuttings had rotted. In 1968, grafting was carried out in January and much work was done to keep the bases healthy before callus formation. Fairly good results were obtained with Benik and Fuchs; results with Hall and Maoz were unsatisfactory (Table B 4.2).

The "nurse" method can be seen as a variation on the theme of rejuvenation: the graft as cutting is rooted during the process of rejuvenation. It can be asked, how would previous treatment influence the results? Of 20 cuttings of Fuchs 20, taken from the first cycle rejuvenation treatment and grafted to be "nursed" on five-month-old seedlings, every one rooted within four months. Thus, these cuttings rooted during the second rejuvenation treatment. Similar results were obtained with other types.

TABLE B. 4.2

ROOTING PERCENTAGE IN SECOND SEASON (Jan.–Oct. 1968) FROM "NURSED" CUTTINGS OF DIFFERENT TYPES

(Where the percentage does not total 100%, the missing cuttings neither rooted nor rotted)

Type	*Rooting condition*				*Rotted*
	Initials	1–2 roots	3–5 roots	> 5 roots	
Benik 31/6	10	20	5	40	25
Fuchs 20	5	—	20	40	15
Hall 30	25	10	—	—	20
Maoz	10	—	—	—	50

In order to study the role of leaves in the rejuvenation process, vegetative "young" Northrop cuttings were grafted on five-month-old seedlings of the same variety. In one group the top of the "nurse" seedling was cut off after the graft had taken and in a second group the seedling top was kept throughout the trial. From this second group not one of the grafts rooted, even after six months, whereas from the first group, without leaves of the stock, leaves grew on the grafts and after five weeks the first root initials were seen.

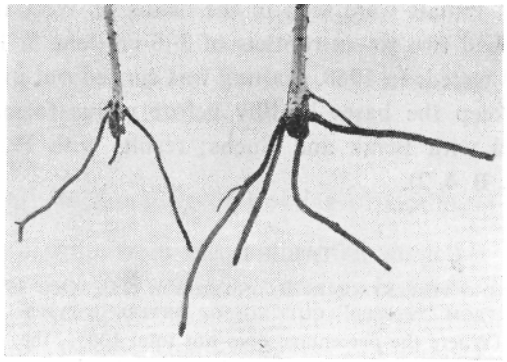

Plate B.4.1. Rooted cutting of Nahalat–10 (West Indian) after second rejuvenation.

In the relatively easy types (GA 13 and Fuchs 20) very good rooting percentages were obtained from cuttings of the first cycle, even without IBA; with Anaheim-3 and Lula-3 (Plate B. 4.1) two cycles brought improvement but not very high values; and with the most difficult type, rooting of a very small number but with a high percentage was obtained only from second cycle cuttings with IBA.

In addition to higher percentage of total rooting, the rooting process was shortened by the juvenility treatment by four to six months. This was found again as a difference between the first and second cycles (Fig. B. 4.1). We have, so far, no figures for the third cycle, but it seems that we may expect further accumulation of juvenility factors.

2. Mexican seedlings five to six months old were approach grafted in April 1967 with different selections. The bases of the grafts were put, like cuttings, into light soil in containers, without treatment with growth substances. Three weeks after grafting, the tops of the seedling stocks were pruned and shortly afterwards eyes on the grafts started to grow. The "nurse" seedlings were pruned further, in accordance with the growth of the grafts, and finally cut at the graft union.

In August the plant was composed of the roots of the "nurse" seedling and the top of the graft (used as cutting).

3. The base of trees nearly always remains much more juvenile than other parts of the tree. The older the tree becomes, the greater the difference in the ability to root, of

material taken from its base and branches. By pruning close to the ground, year after year, material of high rooting potential can be produced continuously.

In order to prepare such material for years to come, 150 vegetative stocks of different selections were planted in a special plot very closely, allowing 1 m^2 per plant. In the first year the plants grew freely and in the second year the new growth was bent and secured horizontally and new growth was encouraged perpendicular to the soil surface. Mulching gave to the bases of this new growth partial etiolation.

The first such plot was planted in 1967, and after 18 months the first cuttings could be taken. The mother plants had reached a diameter of 20 mm at that time, and were semi-woody. Only one cutting — including both base and top — was made from each branch.

The cuttings from the stool bed (Plate B. 4.2) were equal to those from the second juvenility cycle and better than those from the other two groups (Table B. 4.3).

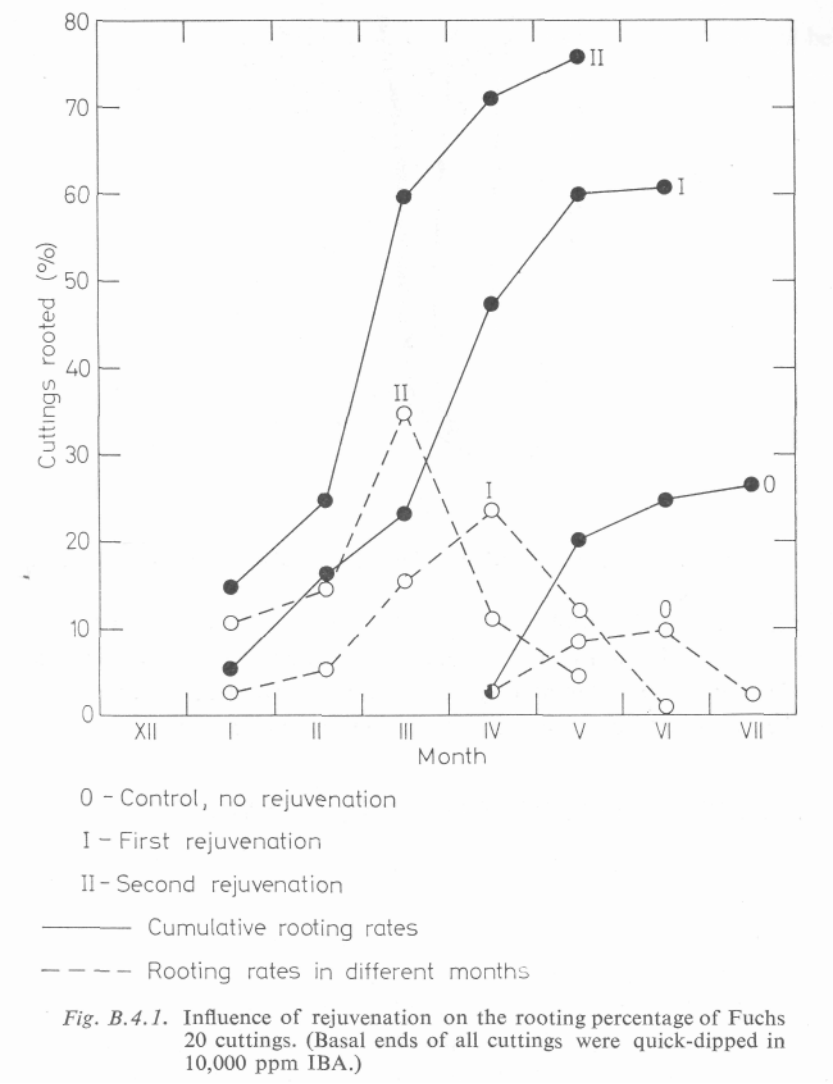

Fig. B.4.1. Influence of rejuvenation on the rooting percentage of Fuchs 20 cuttings. (Basal ends of all cuttings were quick-dipped in 10,000 ppm IBA.)

TABLE B. 4.3

ROOTING PERCENTAGE OF FUCHS 20 CUTTINGS OF DIFFERENT PROVENIENCE, WITH (+) AND WITHOUT (—) IBA
(10,000 ppm quick dip)

No juvenility treatment		*One juvenility cycle*		*Two juvenility cycles*		*Mother plot*	
+	—	+	—	+	—	+	—
23	10	61	44	76	57	75	52

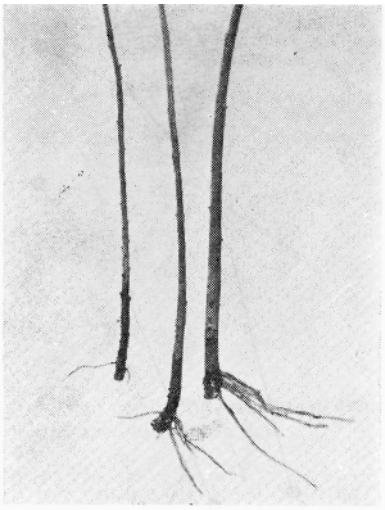

Plate B.4.2. Rooted basal cutting of Anaheim–3, taken from a stool bed.

We intend to use the stool bed from the second or third year on as a source of material for the production of rooted cuttings. The commercial importance of this method of solving the problems depends on the behavior of cuttings in the years to come, *i.e.,* how long a mother plot will give juvenile cuttings.