California Avocado Society 1961 Yearbook 45: 63-66

VEGETATIVE PROPAGATION IN AVOCADOS BY MEANS OF MARCOTTAGE AND THE ROOTING OF CUTTINGS

LeVern B. Young
Graduate student at the University of California, Citrus Experiment Station and Biologist at California Baptist College, Riverside. California.

Vegetative propagation of avocados is necessary where genetically uniform plants are required. The advantages and uses of clonal material have been discussed by Cameron (1). The usual commercial method of producing trees for field plantings is to graft or bud onto a seedling, which gives uniform tops. Each seedling, however, is of a different genetic constitution and makes for a heterogeneous rootstock. Thus, in order to get uniform plants, some type of asexual reproduction is needed for the rootstock also. If plants for the rootstock were produced vegetatively and then the desired tops grafted on, we would have the desired uniformity. One of the usual methods of asexual reproduction is the rooting of cuttings. The production of roots on leafy-stem cuttings of avocados varies with the variety and the age of the tree. When using cuttings from mature trees, such varieties as Zutano and Scott (8) often give 100% rooting. Fuerte, however, roots poorly, while Hass does not root at all. On the other hand, cuttings from seedling trees less than a year old root well regardless of the variety. It has been suggested that perhaps some substance from the seed is necessary for root development (2), but attempts to extract such a substance have been unsuccessful (5). Neither has the application of growth regulators to cuttings from mature trees been successful in developing roots (5).

In general, a high carbohydrate level coupled with a low nitrogen level is optima! for rooting (6). With this in mind, various attempts were made in the present studies to get information as to what substances or conditions might play a role in the rooting of avocados. Two methods were used in making these investigations. One was the marcottage of small branches on mature trees in the field, the other was to place leafy-stem cuttings in rooting beds in the greenhouse. Marcottage was accomplished by removing a ring of bark ½ to 1 inch wide and binding wet sphagnum moss around the girdle with a sheet of vinyl plastic. The ball of moss required the addition of moisture from time to time.

Small branches of mature trees of Duke, Harms, Fuerte, Zutano, and Hass were marcotted in this manner and different combinations of sugar and growth regulators were applied. The sugar was applied as a spray to the leaves, while the growth regulators were applied in a lanolin paste just above the girdle. The concentration of IAA (Indoleacetic acid) was 2000 ppm, and of IBA (Indolebutyric acid) was 1500 ppm. Five marcots were placed on Duke[1], and sprayed with glucose solution (50 gms / 100 mls.). Two were removed prematurely and therefore failed to produce roots, while the other three produced roots in the sphagnum moss. Of the three which rooted, in addition to sugar, one was treated with IAA, one with IBA, and the third with no growth regulator.

Five marcots were placed on Zutano with different combinations of sugar and growth regulators. The only one which rooted was the one treated with both IAA and IBA. but with no sugar. A single marcot placed on Fuerte, sprayed with 10% sucrose, and treated with IAA was successfully rooted. Of five marcots placed on Harms, without sugar or growth regulators, only one rooted, while all four placed on Hass failed to root.

[1]. Two were put on by Dr. Win. Storey.

In all varieties callus tissue formed readily in about three weeks, but roots were not observed until after 5 to 11 months. The roots were small and few in number. Branches which produced roots were from ½ to ¾ inch in diameter. Marcotted branches smaller than this often died; larger ones were not tried.

Since sugar appeared to be a possible factor in root formation, an experiment was conducted in glass covered rooting beds containing a rooting medium of ½ peat moss and ½ plaster sand. Atomizers kept the humidity at a high level. Mature Zutano leafy-stem cuttings were infiltrated with sugar by submerging them in a sugar solution and subjecting them to a vacuum. This procedure caused the air to expand and come out of the leaves. When the vacuum was discontinued, the sugar solution moved into the' leaves causing them to become water-soaked with the sugar solution. Twenty cuttings were used at each of 3 levels of sugar (2, 10, and 25% sucrose) and half of each were treated with IBA and half untreated. After 3'/$_2$ months the controls (no sugar or IBA) had 100% rooting. The various treatments responded with 50 to 100% rooting. Thus Zutano cuttings were not satisfactory for this study and the experiment should be repeated with a variety which does not root so readily.

To investigate the level of nitrogen in relation to leaf drop and the production of roots, mature Fuerte cuttings were obtained through the cooperation of Dr. Tom Embleton from experiments where the level of nitrogen was being controlled and measured. Cuttings were made from trees growing under three nitrogen levels on June 13, 1956. Nitrogen determinations made on leaves obtained from the field on August 20, 1956, were as follows (dry weight basis):

Low nitrogen	—	1.65% nitrogen in leaves
Medium nitrogen	—	1.81% nitrogen in leaves
High nitrogen	—	2.07% nitrogen in leaves

Two rooting beds were operated during this experiment: One was watered with deionized water; the other one was watered with a complete nutrient solution each week plus deionized water as needed. Twenty cuttings were used for each level of nitrogen, ten in the bed with nutrients and ten in the bed without nutrients. The retention of leaves was lowest in the low nitrogen level and highest in the high nitrogen level. Within any one of the nitrogen levels, the number of leaves retained was higher in the rooting bed where nutrients were added. This is the same general pattern as that found for rooting. This suggests a positive correlation between retention of leaves and the production of roots. The percentages of rooting were:

	Low	Medium	High
Bed without nutrients	10%	30%	30%
Bed with nutrients	20%	80%	80%

Due to the small number of cuttings used, statistical .significance was not obtained, but the data suggest that low nitrogen reduces the percentage of rooting. If this is true, it would appear that the lowest level used in this experiment is too low. The higher levels are more optimal and the rooting is much improved by the addition of nitrogen (as well as other nutrients) to the rooting bed.

The retention of leaves is important to the production of roots because the leaves are a source of manufactured food (7). From literature and from the results obtained in the present investigation, it seems dear that cuttings from mature Hass trees do not root, whereas the cuttings made from Hass seedlings root well. One of the problems involved is the length of time which the cuttings retain their leaves. On more than one trial, cuttings made from mature Hass wood lost as high as 70% of their leaves within the first two weeks, whereas in one particular experiment cuttings of seedling Hass did not drop any leaves for a period of 4 months. In order to have mature Hass wood supported by leaves, scions from seedling trees were whip-grafted onto branches of a mature tree in the field. After the scions produced leaves, cuttings were made to include the seedling scion with its leaves plus a portion of the mature wood, so that the seedling part could be placed above and the mature wood placed in the rooting medium. With this arrangement, roots were produced from the mature Hass wood. At about the same time, but unknown to the author, a similar technique was used by Mr. Gillespie (4) for producing roots on cuttings of Fuerte.

Another experiment of a preliminary nature was conducted lo investigate the relation of temperature conditioning to rooting and leaf drop. Three plants of mature Hass grafted on seedling Hass, growing in 1-gallon cans, were kept at different night temperatures for a period of one month prior to making cuttings. All plants were held at a room temperature of 70 to 80°F during a nine hour day and illuminated with fluorescent lights. During the 15-hour dark period the plants were placed in temperature-controlled rooms of 34, 50 and 68°F. After a period of one month the mature Hass tops were made into three cuttings each and placed in the rooting bed. Percentages of leaf drop from cuttings of plants previously held at the following temperatures are stated below.

	34°F	50°F	68°F
After two weeks	70%	0.0%	22%
After one month	100%	23.0%	88%

After three months all the leaves had dropped except for 1 or 2 leaves on the cuttings previously kept at 50 °F. As a result, none of the cuttings rooted.

From the work thus far presented, it may be concluded that an adequate supply of both nitrogen and carbohydrates is needed. There is evidence, however, that more than these two constituents are involved in the rooting of avocados.

The first line of evidence is from the work of Frolich (3) where light was found to play an important role. Difficult-to-root varieties such as Hass were rooted by allowing shoots to grow through some opaque medium to produce an etiolated section of shoot. These etiolated shoots produced roots much more readily than did the non-etiolated shoots. Light may be responsible for the production of some substance which promotes root formation, or for the destruction of some substance which inhibits root formation. Further study as to the quantity or quality of light may be informative. A second line of evidence is the strong polarity shown in avocados. An experiment was conducted with Zutano seedling cuttings. Five cuttings were placed in a rooting bed in the normal upright position and six were inverted. The basal ends of the inverted cuttings which were above the rooting medium, were enclosed in wet sphagnum moss. After two to three months the inverted cuttings had rooted and the roots were growing out through the sphagnum moss into the air. No roots were being produced in the rooting medium from the morphological top end of the cuttings. The cuttings which were placed in a normal position were producing roots from the basal ends. Thus, it would seem to indicate that roots were produced only from the morphological base regardless of position. Such polarity is suggestive of the action of a growth regulator such as an auxin. If a girdle was plated 2 or 3 inches from the basal end of a cutting, roots emerged just above the girdle, even if this girdle was above the rooting medium. A third line of evidence is the abundant formation of callus tissue on the base of cuttings from mature trees and above the girdle on marcotted branches, which indicates that considerable cell division took place without the production of roots. Some cuttings from seedling plants formed very little callus tissue. The observation that roots emerged from the bark above the callus tissue suggests two separate phenomena are operative, namely, callus production and root formation. A ball of callus an inch or more in diameter is often formed with knobby protruberances on cuttings taken from mature trees. A root is sometimes produced from one of these protruberances. This information suggests that some root initiating substance or organizer is needed in addition to cell division. A fourth line of evidence is available from seedling cuttings. From 75 to ¡00% rooting was obtained with cuttings of Duke, Zutano, Wilhorn, Clifton, and Hass. When these cuttings grew into plants 4 or 5 feet tall, they were again made into cuttings. A variety such as Duke responded with 100% rooting, while a variety such as Hass responded with only a fraction of that figure. Nevertheless, several Hass cuttings rooted and grew into healthy plants, which were in turn made into cuttings. These also rooted. The trees in the greenhouse from which cuttings were taken were watered with a nutrient solution on a regular schedule and were in a relatively vigorous state of growth. It may be that the general vigor or growth rate is more important than the age of the tree. In the seedling the growth rate is high as compared to the mature tree.

SUMMARY

Exploratory experiments were conducted on vegetative propagation of avocados by means of marcottage and leafy-stem cuttings. The results are summarized in the following statements.

1. Marcottage produced rooting in all varieties tried except Hass.

2. Cuttings of mature Zutano were infiltrated with sugar and placed in rooting beds. No differential response was found between the treatments and the control group.

3. Cuttings of mature Fuerte were made from trees growing with three levels of nitrogen and placed in rooting beds. Cuttings from high and intermediate nitrogen trees retained more leaves and had higher percentages of rooting than did cuttings from low nitrogen

trees. The use of nutrient solution in each level of nitrogen resulted in higher leaf retention and a higher percentage of rooting.

4. The production of roots on mature Hass wood was accomplished by means of grafting a scion from a seedling onto a twig of the mature tree and allowing leaves to develop on the scion and then making a cutting to include the scion and some of the mature wood.

5. Temperature treatment prior to making cuttings was found to alter the retention of leaves in the rooting bed. A pretreatment of 50°F resulted in a higher retention of leaves than either 34 or 68°F.

ACKNOWLEDGEMENTS

The author wishes to express sincere gratitude to Dr. Louis C. Erickson, Dr. Tom Embleton, and Dr. Wm. Storey of the Citrus Experiment Station for their advice and assistance in carrying out this investigation.

LITERATURE CITED

1. Cameron, S. H. 1955. Propagation of Avocado Rootstocks. Calif. Avocado Soc. Yearbook 39:113-117.
2. Eggers, E. R. and F. F. Halma. 1937. Rooting Avocado Cuttings. Calif. Avocado Assoc. Yearbook (I937):I2I-124.
3. Frolich, E. F. 195I. Rooting Guatemalan Avocado Cuttings. Calif. Avocado Soc. Yearbook 36:136-138.
4. Gillespie, Herbert L. 1957. Stem-rooting Varietal Clones by Means of "Juvenile Growth Phase" Leafy-stem Nurse Cuttings. Calif. Avocado Soc. Yearbook 41:94-96.
5. Haas, A. R. C. 1937. Propagation of he Fuerte Avocado by Means of the Leafy- twig Cuttings. Calif. Avocado Assoc. Yearbook (1937): 126-130.
6. Leopold, A. C. 1955. Auxins and Plant Growth. University of California Press. Berkeley.
7. Van Overbeek, J., S. A. Gorden and L. E. Gregory. 1946. An Analysis of the Function of the Leaf in the Process of Root Formation in Cuttings. Amer. Jour. Bot. 33:100-107.
8. Wallace, A. and C. P. North. 1957. The Scott Avocado. Calif. Avocado Soc. Year book 41:82-84.