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CURRENT TECHNIQUES OF AVOCADO PROPAGATION

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Current techniques of avocado nursery propagation, at least in California, are markedly different than in the past. From a long era of field-grown budded nursery trees (8, 13), the industry has now changed almost entirely to the production of grafted, container-grown trees utilizing plastic greenhouses for the initial stages of propagation. This has been due to a diminishing supply of suitable sites for field production, to the sanitation requirements to avoid infestation of avocado root rot caused by *Phytophthora cinnamomi* Rands and to the advantages of more rapid production of trees.

Commercial nursery production is still primarily based on the use of seedling rootstocks. The variability of seedling populations does not permit the reproduction of selected clones which show particular characteristics in disease resistant, salt tolerance *etc.* (3, 10). There is a definite need, therefore, to develop techniques to provide for large scale and practical vegetative propagation of rootstocks.

Production of Container-Grown Trees

While there are certain deviations based on the individual nurseryman's preference, the basic steps in producing container-grown trees in California are described here.

Seed Collection, Treatment and Storage

Seeds should be from mature fruit picked from the trees—not picked up from the ground—to avoid possible contamination from *P. cinnamomi.* Seed trees must be free of sun-blotch virus.

Seeds to be planted immediately are treated in a water bath at 49-50°C for 30 min, cooled immediately in cold water and surface dried in a well-ventilated area of partial shade (1 7). Some nurserymen dip seeds in a fungicide slurry as an extra precaution.

Heat-treated seeds may be stored up to 3 weeks in closed 0.038 mm (1.5 mil) polyethylene bags at 5.6-6.7°C. Seeds to be stored for longer periods are not heat treated immediately, but are cleaned, surface dried and stored as above. When they are brought from storage, they are then heat treated, surface dried and planted (12).

Planting Seed

Seeds are planted in 0.76 mm (3 mil) polyethylene bags 5.0-6.5 cm in diameter and about 25 cm long with several 7-mm holes punched in the bottom third to allow adequate water drainage. The potting mix must drain well, yet hold adequate moisture. Mixes of 3 parts peat moss to 2 parts perlite or 1/3 peat, 1/3 perlite and 1/3 vermiculite are used.

The seed coat is removed and a thin slice is cut from the apical and basal end of each

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seed to hasten and give more uniform germination. Seeds are planted with the apical end at the surface of the potting mix and are some-limes covered with 6-12 mm of potting mix to reduce drying. Seeds germinate in about 4 weeks.

Grafting Seedlings

The seedlings are cleft or wedge grafted (16) to the desired scion variety 2-4 weeks after germination at a height of 7.5-10 cm above the seed. Grafts are tied with either 6 x 0.4 x 130 mm rubber band or strips of 0.1 mm polyvinyl chloride. Care must be taken to wrap tight enough to hold the graft but not so tight as to injure the succulent seedling stem. Exposed cut surfaces of stock and scion are covered with asphalt emulsion.

Selection of Scion Wood

Freshly cut scions from terminal growth containing plump buds and of the same diameter as the seedlings being grafted are preferred. Scions should be from registered sun-blotch-free sources. Scion wood may be stored for a month or 2 in closed polyethylene bags at 6-7°C if necessary.

Propagation Houses

Structures for propagation vary in size but are normally plastic-covered houses with temperatures maintained between 16° and 32°C by vented heaters or evaporative coolers. Humidity is maintained at 70-80% by use of misting systems. The young plants are grown on raised benches and strict sanitary measures are practiced for disease prevention. Irrigation is done either by hand sprinkling or by use of overhead sprinklers or misters.

Transplanting to Large Containers

The plants are transferred to a 50% shade house 4-6 weeks after grafting and held for approximately 2 weeks to harden off. They are then transplanted into 18 x 46 cm, 0.2-0.25 mm thick, polyethylene tube containers which are open at both ends and placed in outdoor growing grounds. Some nurserymen use a felt roofing paper lining to reinforce the plastic container.

The planting medium or mix to fill the large containers varies in composition, depending on the nurseryman. It must be a mixture that drains water easily and remains friable. Various combinations of soil, sand and organic matter are used. The planting medium is fumigated or steam sterilized before use to protect from possible *P. cinnamomi* infection and beds or areas on which the containers are to be placed are also treated. The open-end container bottoms should rest on soil, not gravel beds, to ensure adequate water movement from the container.

Tree care

Nursery trees are irrigated through a microtube system to each container with amounts and frequency depending on tree size and climate. Fertilization is accomplished by injection through the irrigation system. The trees are staked, tied and trained up the stake as they grow.

Under California conditions and depending on the season, trees will be ready for orchard planting 11-18 months after planting the seed. By this general method, nurserymen have

produced nearly 2 million trees in California in recent years.

Clonal Propagation

Clonal or vegetative propagation of avocados has been studied by a number of investigators for some time. While some of the techniques tried have been successful, the application of the techniques developed, in most cases, has not been adaptable to the production of large quantities of trees on a commercial basis. One of the problems has been the variability in ease and consistency of rooting found between races and between cultivars within each race. Generally, cultivars of the Mexican race root most easily, those of the Guatemalan race next and those of the West Indian race least easily (10, 13). Within each race, however, some clones do not conform to the rooting characteristics of that race. Anatomical studies of avocado stems from clones of different races have shown differences in the fiber sclereid ring, which may explain the variability in rooting capacity (5). Often, it seems that the desired clone or selection to be propagated falls in the shy-rooting category.

Review of Techniques

Investigators have found that stem cuttings taken from very young avocado seedlings root readily, indicating that a juvenility factor is responsible (1, 7, 9, 11). This method, however, does not permit reproduction of large numbers of a single selection. Stem tip or terminal cuttings from older trees have been found to root better than those taken from more mature growth, but results are not consistent for all clones (10, 11). Trials with rooting hormones have shown improved rooting in some clones but results in general have been inconsistent (6, 10). Marcotts or air layers have been investigated with varying degrees of success (4, 14). Various grafting and inarching techniques have been studied but these appear to be adaptable to the reproduction of relatively small numbers of plants (15). Attempts have been made to utilize tissue culture techniques as a means of clonal propagation for avocados but, to date, these investigations have not resulted in success (T. Murashige, personal communication).

In California we have been faced with trying to find a reliable and economical method of clonal reproduction of certain rootstock selections found to have some tolerance to avocado root rot. Unfortunately, those selections currently in use do not root readily by conventional means. The various techniques already mentioned were reviewed but did not appear promising for the reproduction of larger numbers of the selected clones. Therefore, the technique of etiolation (producing tissue in the dark) was chosen as the method of clonal propagation (2, 3).

Etiolation Technique

The technique of rooting avocado cuttings by etiolation has been described and illustrated (3) so it will not be discussed in detail here. Briefly, however, the technique is as follows:

1. A large seed, producing a strong seedling, is planted in a 1-liter container.
2. The seedling is tip grafted as close to the soil level as possible with the variety to be rooted when it has reached a diameter of about 7 mm near the base.

3. The scion is allowed to grow until the union is well established, then cut back to near the base of the scion. This becomes the nurse plant for cuttings.
4. The whole plant is placed in a dark chamber maintained at 21-24°C when scion buds again show signs of growth.
5. The plants are brought to the light after shoots growing in the dark have made 7-10 cm of growth. A collar is placed around the stem and filled with vermiculite to continue exclusion of light from the base of the shoots. Tips of shoots are left exposed to light but shaded until chlorophyll develops in tin- exposed developing leaves.
6. Shoots grow until several leaves have matured, then are detached at the base (which is devoid of chlorophyll) and placed in propagating frames or cases for rooting. The nurse plant is then returned to the dark chamber to produce more shoots.
7. The cuttings, when rooting occurs, are transplanted to 10-cm peat pots filled with a friable soil mix and held in closed propagation frames until adequate roots develop.
8. The established cuttings are then transplanted to larger containers for growth to the required size for grafting and field planting.

A variation of this method is to girdle the etiolated shoot near its base rather than detach it from the nurse plant. The collar and vermiculite are then placed and rooting occurs within the collar. The rooted etiolated shoot is detached after roots have initiated and handled as a routed cutting.

Adaptations and variations of the etiolation technique are currently being explored by researchers and nurserymen in an effort to provide a more economical way to produce rooted cuttings in greater volume at lower cost. As investigations continue, techniques will be developed to overcome some of the frustrations of avocado clonal propagation.

Summary

Production of Container-Grown Trees

1. Mature seeds from sun-blotch-free trees are heal treated in a water bath for 30 min at 49-50°C for *P. cinnamomi* prevention, cooled and surface dried They are planted immediately or held up to 3 weeks at 5.6-6.7°C in closed polyethylene bags. Seeds may be stored for longer periods, but are not heat treated until removal from storage just prior to planting.
2. Seeds are planted in polyethylene bags 5.0-6.5 cm in diameter and about 25 cm long with several 7-mm holes in the bottom third. Various good draining potting mixes are used.
3. Seedlings are cleft or wedge grafted 7-10 cm above the seed. Grafts are tied tightly enough to hold the graft securely but not so tight as to injure the succulent seedling stem. Scions from freshly cut terminal growth with plump buds are preferred.
4. Propagation structures are plastic-covered and maintained between 16º and 32ºC

with humidity at 70-78%. Plants are grown on raised benches and strict sanitary measures are followed.

5. Grafted plants are transferred in 4-6 weeks to a 50% shade house to harden off, then transplanted to large containers filled with sterilized planting medium and placed in outdoor growing areas.

Clonal Propagation

1. Certain clones root readily while others do not. Several clones used as rootstocks for disease or salt tolerance fall in the shy-rooting category. Propagation of such clones in large numbers is desirable.
2. Techniques using juvenile cuttings, rooting hormones, marcotts, inarch grafting, etiolation and tissue culture have been explored. Etiolation appears best suited for shy-rooting clones in California.
3. The etiolation technique consists of growing a strong seedling; tip grafting just above the soil level to the desired scion; allowing scion to grow until well established; cutting scion back to near its base to form nurse plant; when buds appear on scion, nurse plant is placed in dark chamber until shoots have made 7-10 cm growth; nurse plants are brought to light and a collar is placed around stem and filled with vermiculite to exclude light from base of shoots; tips of shoots are exposed and allowed to grow until several leaves have matured; shoots with bases devoid of chlorophyll are detached and placed in rooting beds; nurse plants are returned to the dark chamber to produce additional shoots, when detached shoots are well-rooted they are placed in containers for growth and grafting to desired scions.
4. A variation of the technique is to girdle the etiolated shoot near its base before detaching; the collar and vermiculite are replaced to allow rooting to occur in the collar.

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