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Propagation Experiments with Avocado, Mango, and Papaya

HAMILTON P. TRAUB and E. C. AUCHTER
U. S. Department of Agriculture, Washington, D. C.

During the past year several different investigations relative to the propagation of the avocado, mango and papaya have been conducted in Florida. In this preliminary report, the results of a few of the different experiments will be described.

Germination media:—Avocado seeds of Gottfried (Mex.) during the summer season, and Shooter (Mex.) during the fall season; and Apple Mango seeds during the summer season, were germinated in 16 media contained in 4 x 18 x 24 cypress flats with drainage provided in the bottom. The eight basic materials and eight mixtures of these, in equal proportions in each case, tested were: 10-mesh charcoal, 6-mesh charcoal, pine sawdust, cypress sawdust, sand, fine sandy loam, carex peat, sphagnum peat, sand plus loam, carex peat plus sand, sphagnum peat plus sand, carex peat plus loam, sand plus coarse charcoal, loam plus coarse charcoal, cypress sawdust plus coarse charcoal, and carex peat plus sand plus coarse charcoal.

During the rainy summer season, with relatively high temperature and an excess of moisture without watering, 10-mesh charcoal, and the mixture of carex peat plus sand plus charcoal proved most rapid, but for the drier, cooler fall season, when watering was necessary, the mixture of cypress sawdust plus charcoal was added to the list. During the rainy season the two charcoal media, sphagnum peat, sand plus charcoal, cypress sawdust plus charcoal, and carex peat plus sand plus charcoal gave the highest percentages of germination at the end of 6 to 7 weeks, but during the drier season the first three were displaced by carex peat plus sand, and sphagnum peat plus sand.

Seedlings were in the best condition, on the basis of stem diameter, height, leaf size, root length, branching, and soundness, and general thriftiness of the whole plant, at the end of the experiment during the rainy season in sphagnum peat; and cypress sawdust plus charcoal, but these were replaced by sphagnum peat plus sand, and carex peat plus sand plus charcoal for the drier season.

The use of 10-mesh charcoal accelerates germination during both seasons and is apparently otherwise beneficial during wet weather. However, sand may be substituted in some mixtures to obtain highest percentage of germination and best development during the drier season. Sphagnum peat causes less decay of seeds and roots than

[1]After this paper was presented at the Boston meeting of the Society, the authors' attention was drawn to other somewhat similar work in which whole sprouted embryos were used as contrasted with the dormant or sprouting fractional embryos used in our work. Cornu grafted tender scions on the "collar a little below the attachment of the cotyledons" in chestnut, walnut, Pavia, and rosaceous stone fruits. (Jour. Soc. Nat. Hort. France, 3 ser. 17:505-510. 1895; *ibid.* III 20, 90. 1898; Ballet, L'Art de Greffer. Paris, 264. 1902). Rockens inserted tender grafts of *Clianthus* in the split plumule of *Colutea* plants a few days old. (Rev. de. l'Hort. beige et étrangère. 31: 7-9. 1905).

carex peat.

The results for Apple mango seeds, though not as clear as those for the avocado seeds, show conclusively that 15 other media tried are much superior to Orlando fine sandy loam.

The experiment will be repeated during the winter season, and will be continued next season with a smaller number of media which appear superior. Some of the poorer media, such as fine sandy loam, which appeared inferior under the conditions of these experiments, will be eliminated.

Germination of immature avocado seeds:—These experiments have for their purpose to determine how early in their development avocado seeds can be sprouted and at what stage such immature seeds can be used for commercial propagation purposes. This subject also has important bearing on breeding operations; since the avocado is notorious for the number of fruits shed. Sprouting immature seeds may save valuable breeding material.

A small percentage of very immature seeds, Collins (Guat.), Winslowson (Guat. x W. I.), Mayapan (Guat.), gathered during the May and June drop of the past season sprouted, and more than 95 per cent of the seeds from fruits blown from the trees at the Orlando station during the hurricane of September 3, 1933, have germinated and are producing excellent plants. Even the immature seeds from the late maturing variety, Collins (Guat.) produced seedlings. The seed maturity ranged from 35 per cent for Collins (Guat.) to 80 per cent for Mayapan (Guat.) and Perfecto (Guat.) on the basis of comparison of weight of immature seed with weight of previous season's mature seed.

Sprouting fractional embryos:—When the two avocado cotyledons are broken apart, a fraction of the meristematic tissue will remain attached to each. In some types of seeds these fractions are approximately equal, in others this generally does not hold true. The explanation in terms of physical laws has not as yet been worked out. However, no matter how small the fraction of meristematic tissue, it usually sprouts under favorable conditions. These halves may in turn be cut into two approximately equal parts each with approximately a quarter of the meristematic tissue and these usually sprout. The process might conceivably be extended even farther, but the percentage sprouting from eighth embryos is apparently markedly delayed or reduced as compared with quarter embryos, from causes not definitely determined.

Average measurements, at intervals from April 8 to October 17, of stem diameter and height of Collins (Guat.) plants, secured from whole, half and quarter embryos, show that plants from fractional embryos lag behind those from whole embryos. Although in this case the plants from fractions did not reach the same stem diameter and total height as the controls from the whole embryos, a large percentage did reach a trunk diameter of 6 mm. In root development the plants apparently were equal to the controls. Splitting the embryo into fractions may be compared to the pruning process, which has a dwarfing effect. This might account, in part, for the lag of the above-ground portion of the trees from fractional embryos. This subject must, however, be considered in the light of the size of the avocado seeds. Plants from small seeds as a rule are smaller at a given time than those from larger seeds. Therefore, plants from fractional embryos secured from small seeds might not reach the necessary ¼ inch stem diameter wanted for ease in budding in the desired length of time.

These results with the sprouting of fractional embryos, used in connection with the method of budding avocado embryos on small or large trees (2) in genetic studies, makes it possible to overcome the objection to the method, that in case of failure in securing union the variate would be lost.

Sprouting mango embryos may be cut into fractions which will produce multiple sprouts when planted. With polyembryonic varieties this would apparently have no practical value, but may be worthy of consideration as a means of increasing the number of progeny from mono-embryonic seeds for use in plant breeding and phytopathological experiments where it is necessary to test sexual offspring in different locations and with various inoculations.

Avocado fractional embryo graftage:[1]—As announced in a previous paper (3), this work has been extended to include the testing of variations of the general method and also the influence of kind and condition of graftwood, varietal differences, and propagation media. It is of interest to note a method which has been brought to our attention since the publication of our preliminary announcement (3). In this case the sprouting embryo is used as a bud (2) and the object and types of grafting are the reverse of those which we set forth. The method used in breeding work to shorten the time required to determine the value of seedlings, "consists in using the newly started embryo of a sprouting seed as a bud either in nursery stock or in the limb of a large tree, one of the two large cotyledons is carefully removed with a sharp knife without disturbing the developing plantlet. A sharp cut is made beginning at the base of the tiny shoot and extending through to the root tip. The other half of the seed is sometimes cut away, leaving a small wedge-shaped portion to assist in forcing the rootlet into the incision, or it may be left on entirely" (2).

In general the method of fractional embryo graftage consists of wedge grafting a cion, 2 to 5 inches in length, into the meristematic tissue of the fractional embryo either vertically from the top or at an angle of about 45 degrees, into the center of the embryo where it unites with the cotyledon. The fractional embryo may be used in at least three developmental stages, (a) dormant, (b) just sprouting, and (c) sprouted still farther. In a variation of (a) and (b) above, the whole embryo may first be sprouted and then split lengthwise into approximately equal parts including the root or roots.

Avocado seeds are of various shapes, from long, narrow, pointed to approximately spherical and flattened. It will facilitate matters to describe the insertion of the graft in the latter case, where a cotyledon represents an approximate hemisphere. First a section shaped like an acute pyramid, with its point in the center of the fractional part of meristematic tissue, is removed. In performing the operation, two cuts, from 1/4 to 1/8 inch apart are started at the edge of the cotyledon at the plumule end, or 45 degrees in either direction on the edge. The cuts are slanted inward at an angle of approximately 25 degrees on the flat side of the cotyledon toward the center of the embryo, and also toward each other, at an angle of approximately 45 degrees, on the curved side of the cotyledon. When these cuts are carried to their intersection the desired section may be removed. The scion is prepared to fit into the opening. Beginning at the base of the lower bud with even strokes of the knife, a three-sided pointed wedge is formed. The uncut curved surface is placed on the outside and the pointed wedge toward the center of the opening in the fractional embryo. The pointed wedge is then inserted firmly but not too tightly with the point in the center of the fractional embryo, for care must be exercised not to crush the cells. No tying is needed. Any exposed cut surfaces should then be covered with 45 to 49 degree C melting point paraffin (1). Care must be exercised not to force the paraffin between the scion graft and the meristematic tissue of the fractional embryo. The opening on the curved side of the cotyledon is filled with paraffin, the graft being held at a slight angle with the scion uppermost.

Grafts are planted either sideways or flat side up at an angle of 45 degrees C in flats 5 inches high. The types of propagation media of most value for this purpose have not been determined experimentally. The grafts can be planted in 6 x 6 x 12 cypress boxes or nursery row as soon as sprouts appear.

There is varietal difference with respect to ease of graft union. The effect of race, Guatemalan, Mexican, and West Indian, of both stock and scion on the results are being investigated. The kind and condition of graftwood as well as the seasonal changes have a marked effect on the response.

Mango sprouting embryo graftage:—Although the costly inarching method is still practiced, most nurserymen now use either the shield budding or whip grafting methods in the propagation of the mango. However, success with the last two have been achieved only by few. During the past 2 years limited experiments have been tried with grafting sprouting mango embryos for the dormant mango embryo is not far enough advanced to make graftage practicable.

The mango sprouting embryo is very brittle and the operation is delicate. The plumule is cut off near the base of the cotyledons, a slit is made down the center between the cotyledons, and the wedge shaped scion, 2 to 4 inches long, is inserted at a slight angle and tied with a rubber band not too tightly since the tissues are very succulent and easily injured. The exposed cut surfaces are covered with 46 to 49 degrees C melting point paraffin.

The grafts are planted at an angle in a sprouting medium contained in flats 5 inches high. The grafts sprout as a rule within 3 weeks. These should not be transplanted until the new growth has hardened.To save the greatest percentage of sprouted grafts it may be necessary to sprout them in individual pots. The percentage of successes for various lots ranged from 0 to 80 per cent. Further attempts will include the study of the effect of kind and condition of graftwood on the response.

Papaya cuttage experiments:—Experiments in propagation of papaya, and also with avocado and mango, by cuttage and layering have been a disappointment so far. Extensive cuttage experiments with papaya (more than 300 cuttings), and avocado (more than 2000 cuttings) under ordinary slat shed propagation conditions have proved a total failure. In both cases callusing has been accomplished, but no root formation was secured. In the case of the papaya much decay was present unless the cuttings were covered with bell-jars to increase atmospheric humidity. In further experiments the influence of bottom heat on the response will be determined.

LITERATURE CITED

1. POPENOE, WILSON, and BUTLER, ALFRED F. Propagation de l'Avocatier. Rev. Bot. Appl. et D'Agric. Coloniale. 8: 478-482. 1928.
2. RYERSON, KNOWLES. Embryo budding of the avocado. Jour. Heredity 15:33-37. 1924
3. TRAUB, H. P., and AUCHTER, E. C. Sprouting and grafting fractional parts of avocado embryos with attached cotyledonous material. Science 78:389-390. 1933.