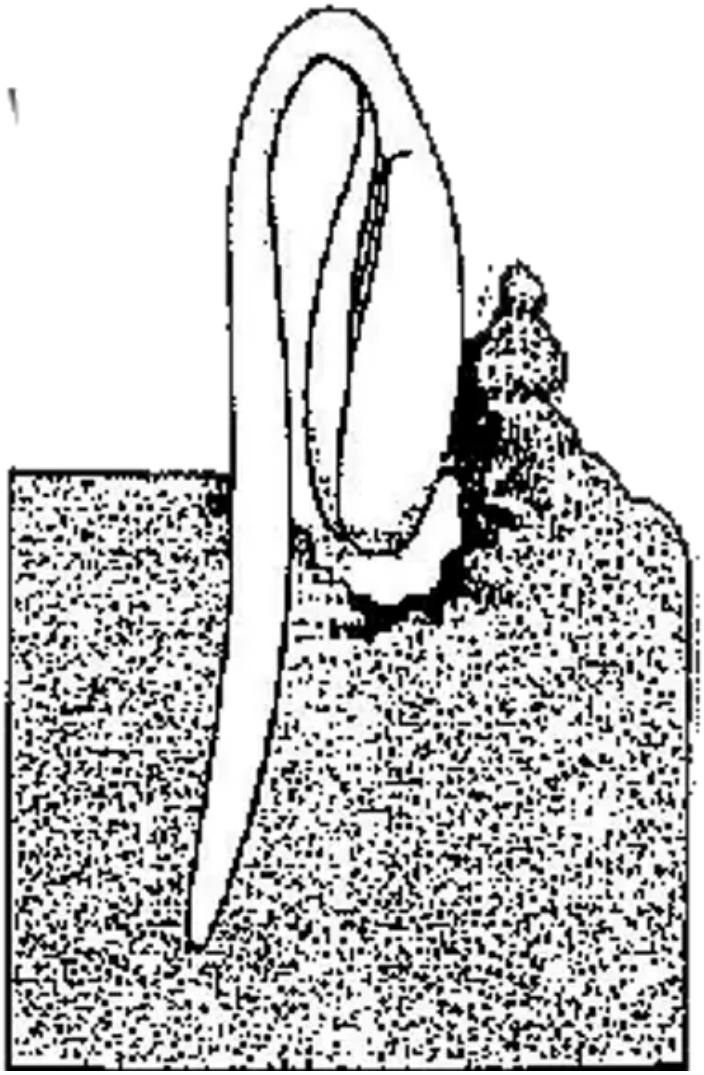
Germination and Propagation

- Measuring the Viability of Your Seeds (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Meas)
- Germinating Seeds Containing Chemical Inhibitors (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Germ)
- Tropical Onion Seed Germination (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Trop)
- Chart on Procedures for Growing Tropical Fruit from Seed (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Char)
- Will Carambola Trees Come True from Seed? (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Will)
- What Varieties of Citrus Will Grow True from Seed? (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#What)
- Purchase of Citrus Seeds and Budwood (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Purc)
- Answers to Some Questions on Citrus (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Answ)
- Are There Dwarf Citrus Trees? (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#AreT)
- Growing Your Own Grafted Subtropical Varieties of Deciduous Fruit Trees (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Grow)
- Difficulty Germinating *Paulownia* Trees? (https://www.echocommunity.org/resources/edfaefc2-dc4d-4583-8a8e-e1bff2a5a49b#Diff)

MEASURING THE VIABILITY OF YOUR SEEDS. It is a good idea to check the viability of your seeds before planting time. If the percent that germinate is low, you will know to plant a larger number of seeds. It is very important to test the germination of seeds that you have stored, and old garden seeds that have been given to your project. Local farmers can be seriously hurt if they rely on those seeds when the critical planting time comes, only to find that they germinate poorly or not at all.

We used this method to check the seeds in our seedbank. Remove a representative sample (do not select the biggest seeds) of 20 seeds or more from the container and **label it.** (The sample size depends on how many seeds are available. The larger the sample, the more reliable the results.) Soak the sample in 10% bleach for two minutes, then drain and rinse with water. Distribute the seeds on a clean damp paper or cloth towel and roll it carefully into a long cylinder. Enclose it in a plastic bag and store it in a warm damp place. Label each roll. Record the number of seeds that have germinated each day or two. Remove those that germinate, and replace the roll until the next inspection. Remember that seeds vary widely in the time it takes to germinate. Some germinate in 3 days, while others take 3 weeks or even longer for many fruit seeds. (Once we had a vegetable ivory palm come up from a seed that we had planted 16 months earlier!) Finally, calculate the percent that have germinated.

David Knight in Zaire asked, "Why is it necessary to count the germination on each of several days?" There are two criteria for (/resources/f09fb6dd-cb1c-42a2-98bc-

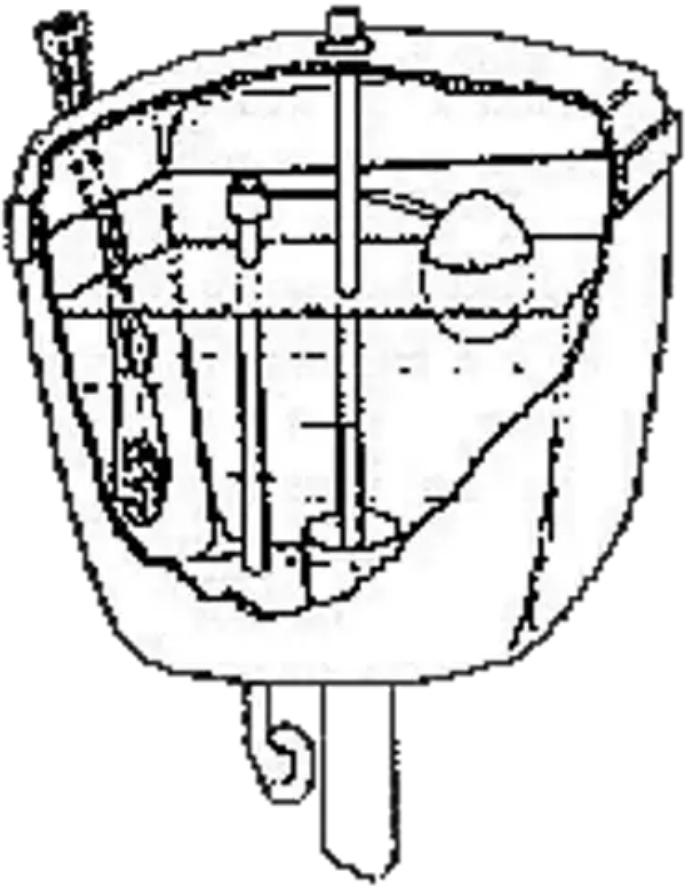


3315cae5ac3e)good seed that the viability test measures: how many will germinate and how uniformly they will germinate. Sometimes a few seeds in a package will germinate quickly, followed by a few each day for several days. For example, winged

beans often have non-uniform germination rates. Some kind of fruit tree seeds can do this to an extreme. It is helpful to know what to expect so you will know to keep watering. If you only want to know the percent that will germinate eventually, you can wait a few weeks to make the count. A disadvantage of uneven germination is that thinning and harvesting is extra work when plants germinate and grow at different times, but a strength is that more of the seeds are likely to survive in the event of a drought or some interruption just after planting.

ECHO tries to test the germination of each active accession in our seedbank at least annually. The procedure we currently use measures emergence from the soil, in addition to seed viability as described above. (A seed may be alive, and it may even germinate, but emergence is the true test if it is to take root and grow.) It is a simpler test and allows us to transplant the plants after the test, as well. Count out, label, and plant a sample of seeds. Record the tally every week to obtain your germination rate. (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

GERMINATING SEEDS CONTAINING CHEMICAL INHIBITORS. Seeds of some wild species contain chemicals that inhibit germination. "For such species, continuous leaching in running water for up to two weeks is needed--washing or



(/resources/bd2604fe-fff5-4e4d-94e8-5a7f839fdde9)soaking is not enough." A recently published book, *Germination of Local Native Plant Seed for Revegetation, Tree*

Planting and Direct Seeding Projects (Murray Ralph, A$13.45 from Granny Smith), gives a novel solution. "The seed is placed in a permeable bag, such as a nylon stocking, and hung in your toilet cistern. The cycles of soaking and flushing produced in the cistern are ideal for easy breaking of the chemical-based dormancy." (Adapted from *Quandong,* Vol 21 #2, 1995; Nut and Tree Crops Centre, P.O. Box 27, Subiaco, WA 6008, AUSTRALIA.)
(https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

TROPICAL ONION SEED GERMINATION was poor, according to the seed trial reports many of you returned to us. Onion seeds are short-lived, so we were not surprised to see some reports of low germination in the field. However, the onion seeds in our seedbank were continuously tested for acceptable germination, and at ECHO we successfully grew many of the onion varieties for evaluation. Based on your results, we asked the researchers who supplied ECHO with the onion trials to send us fresh seed. This comment from their letter may explain why some people enjoyed great onion harvests while others had no germination:

"Please note that the onion seed sent to you is packaged very dry, so **the packets should be opened and the seed allowed to take in moisture from the atmosphere overnight before the seed is sown.** You risk damaging the seed by imbibition [water uptake] injury if it is sown straight from the packet into damp ground. Another approach is to sow the seed into dry ground, then water it the following day. This also allows it to equilibrate naturally before it gets wet. Seed not wanted for use at once should be resealed in the foil packet immediately after removal of the amount you need, not allowed to remain open to the air for long."

It is generally good to let well-dried seeds sealed in airtight packets absorb some moisture from the air before planting them directly in wet soil. Other seeds harvested at ECHO for our seedbank are dried thoroughly, but not so much that such imbibition injury is likely.

If you had poor results with the onion trials, write ECHO for more seed and let us know your results using this method. Your seed trial reports are very important to us in identifying problems such as this, as well as learning of successful introductions of the crops in our seedbank. Harvest report forms which accompany the seeds should be returned to ECHO. People interested in conducting an extensive onion study should contact Dr. Lesley Currah, Horticulture Research International, Wellesbourne, Warwick CV35 9EF, UK.
(https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

CHART ON PROCEDURES FOR GROWING TROPICAL FRUIT FROM SEED. The California Rare Fruit Growers publish the excellent magazine *Fruit Gardener,* which would be extremely interesting to folks working with fruits in the tropics. We copied a table from one issue that lists storage life of seeds, type of storage that is needed, dormancy breaking requirements, days to germination and cold hardiness. It covers 92 genera. We will send a photocopy to you upon request. Subscriptions (6/year) are US$16 in US, $25 Canada/Mexico, $30 foreign surface, $40 airmail from California Rare Fruit Growers, The Fullerton Arboretum, CA State University,

Fullerton, CA 92634; 714/638-1796. This is among the favorite magazines in ECHO's library. (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

WILL CARAMBOLA TREES COME TRUE FROM SEED? Carambola fruit, *Averrhoa carambola,* also known as "star fruit" has gone from an obscure, inexpensive fruit in the U.S. to an exceptionally expensive "yuppie" fruit. When sliced, the star shape makes it popular on top of fruit salads, added to stir-fried vegetables, dried, or as a decorative addition to desserts. (/resources/954faac4-9f9e-4dd2-b5eb-

32282a082bac)Most people in southern Florida who have tasted the old dooryard seedling trees find the fruit too sour to be of interest. They are usually amazed to taste the new, sweet grafted varieties. Since carambola bears at a young age and produces one of the heaviest crops of any small tree over a long season, the good varieties are great dooryard trees.

We wondered what would happen if ECHO sent out seed taken from fruit of one of the superior trees. Would it give fruit just like the parent, or would the fruit be sour and unappealing? To find out, we planted seven seeds taken from the commercial yellow Florida variety 'Arkin.' The great variation in shape and flavor is such a good demonstration of why people prefer grafted fruit trees (where every tree is like its parent) that we have left the entire planting to use in our educational program.

Trees began to produce fruit in 2-3 years. Four give orange fruit, but on three the fruit turns from green to nearly white, to pale orange as it ripens. Two of the orange-fruited trees are very sour, one is moderately sour, and the other is sweet. Two of the

light-colored fruits are slightly sour with fair flavor, but we think that one tastes as good as or better than commercial varieties. (It will not become a commercial variety because the ideal commercial shape here is long with short "wings," which are less likely to be damaged in shipping. All these seedlings were shorter and had longer wings than the commercial varieties.) Several are good enough to leave for fruit production.

If you do not have sweet carambola in your country, you may request a packet of seed and we will send seed when available. Seeds reportedly cannot be stored, so we will probably send them in moist peat moss. They may be germinating by the time they arrive, so plant at once. You will probably find that you like fruit from some trees very much and some not at all. You may even find one that will be so good it will become a new variety for your country. (At ECHO we graft our best varieties to limbs of trees with sour fruit.)

ECHO's interns tell us carambola is one of their favorite juices. They remove any green tips on the "wings" (which can have an off-flavor) and mix with some kind of citrus juice and sugar. Dr. Julia Morton warns that the content of oxalates is so high that the fruit should not be consumed in large quantity. The less sour varieties have less oxalic acid. (An ECHO intern once read a research report which stated that most of the oxalates are found in the "wing tips" of the fruit, so presumably cutting off the tips could reduce the oxalate content. We have not been able to locate the report to confirm this, however.) (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

WHAT VARIETIES OF CITRUS WILL GROW TRUE FROM SEED? Jerry Larson with Double Harvest in Haiti asked us (/resources/de9e5387-2eba-4526-a9e4-

602f49b9350f)what varieties of citrus might come true from seed. I checked with Dr. Carl Campbell at the University of Florida Extension research center, who gives us many in-depth, insightful answers to tropical fruit questions from our readers. He said that a great number of citrus trees will come true from seed. You can tell by examining a few seeds from the tree. Peel off the outer and inner seed coat; if the seed is polyembryonic (i.e. has many embryos) it will come true. (In some of the polyembryonic citrus, **some** of the embryos are of gametic origin and therefore do

not come true. The percentage varies by species and variety.) I asked what it would look like if it were polyembryonic. Carl said that the various embryos would be convoluted upon each other. If it is mono-embryonic there will be one embryo with two distinct cotyledons. Almost any sweet orange will come true from seed, as well as key limes, grapefruit, tangerine and tangelo. Two varieties that will not come true from seed are temple and pomelo.

What are the advantages and disadvantages of growing citrus from seed when that is possible? One obvious advantage is that it is much less labor intensive to simply sow citrus seeds and eliminate the grafting step. Another advantage is that the seedling will most likely be free from viruses that sometimes get into the budwood that is used for grafting large numbers of trees. I asked Carl about reports that non-grafted citrus trees live longer, up to twice as long, as grafted trees. He said that this can be true, depending on the number and kinds of disease organisms that may be present in the budwood. If one uses certified disease-free budwood, and if there are no microorganisms present that we do not even know to look for yet, then there should be no difference in the longevity of the trees.

One advantage to grafting is that one can combine the best traits of the above ground part of the tree with the best adapted rootstock for the particular soils and conditions of the area. A seedling will tend to grow upright, tending toward a single trunk, and becoming quite thorny. A grafted tree will be more highly branched. The seedling tree will not fruit for 6-7 years, contrasted to 3-4 years for a grafted tree. The earlier fruiting of the grafted tree is partly responsible for the more highly branched form of growth. Apparently the weight of the fruit after about 3 years bends the branches and causes new buds to begin growing, resulting in a more highly branched tree. But not all of the reasons for the differences between seedling and grafted trees are known.

If you live in an area where citrus is not a major crop but would like to introduce it, you might consider trying some of the polyembryonic seeds. If you are more adventuresome, in a few years also plant some accepted rootstock varieties for grafting using budwood from the new trees you have introduced. If you prefer to start with a Florida variety rather than a good local variety, and want only a few seeds, we can at times provide them. If you want larger amounts, request a price list from Chuck Reed at Reed Brothers Citrus (see below), who routinely ship overseas; he can provide phytosanitary certificates if you so request and include your full address and phone number. I asked about the danger of introducing a new disease. This does not appear to be a problem with citrus seed. A citrus disease has never been proven to have been introduced by seed.
(https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

PURCHASE OF CITRUS SEEDS AND BUDWOOD. Carl Berg, a Peace Corps volunteer in Ecuador, inquired about citrus rootstock and how best to introduce assorted varieties of citrus into his part of the country. I phoned Reed Brothers Citrus for help.

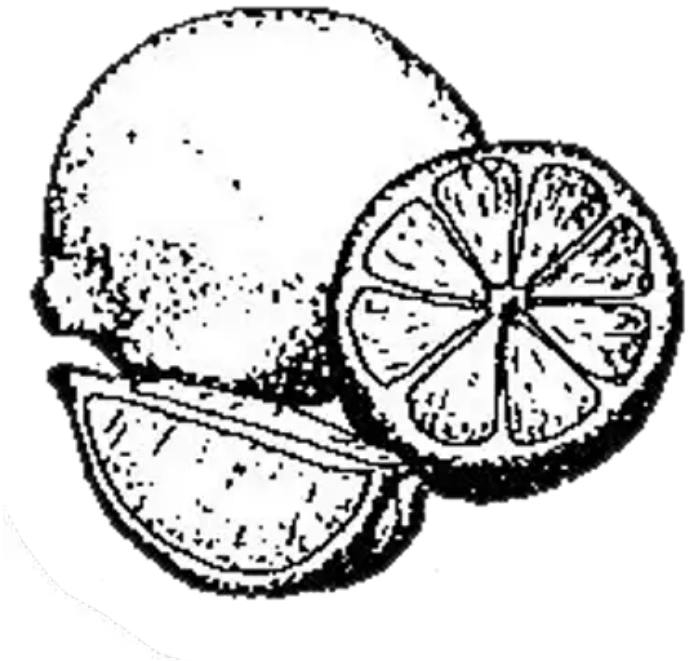
Some rootstocks that they recommend for almost anyone, anywhere (though they sell many more) are: sour orange (no longer a commercial variety in Florida, as it is susceptible to the tristeza virus), `Carrizo' citrange, `Swingle' citrumelo, `Cleopatra' mandarin and *Poncirus trifoliata* (trifoliate orange). If there is no danger of freeze or

frost, he would add to the list `Volkameriana' for lemons and limes. Order sour orange and Poncirus before September of the year before so they can specially acquire seeds for you.

The prices per quart range from $40 to $70, so most of ECHO's collaborators would be unable to try more than perhaps one variety. I asked if he would be willing to prepare an assortment in smaller packets. He agreed to the following. You can send him $50 for an assortment of some or all of those mentioned above, ask for an assortment of citrus that will come true from seed, or a combination of these options. He will arrange packet size to make the bill come out to $50. We agreed to allow him some flexibility, as he would not have time for precise measurements, etc. You will receive approximately 1.5 pounds of seed. I would recommend that you add about $20 for airmail postage, as citrus seeds begin to lose viability within a few weeks after removal from refrigerated storage. Alternatively, if someone in the States is about to visit you, the seeds could be sent to them via UPS. Mr. Reed is doing this as a favor to help your work and does not assume responsibility for delivery by international mail systems. Send your order, mentioning the ECHO package arrangement, to Mr. Reed at Reed Brothers Citrus, P.O. Box 1863, Dundee, FL 33838, USA; phone 239/439-1916; fax 239/439-4268.

The citrus canker scare in Florida has been cleared up, so Reed Brothers Citrus can ship budwood again; write them for a price list. You should be aware that many countries have strict budwood regulations, so check on your regulations before purchasing. (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

ANSWERS TO SOME QUESTIONS ON CITRUS. Two of our readers asked some interesting questions about citrus. We (/resources/871f04f7-92b8-4c34-bd5a-



95020fb20b3c)called Reed Brothers Citrus (see above) for some help.

Q. (From William Boykin in Zambia.) "The navels, valencias and hamlins do not have the sweet flavors we had hoped. Is there anything we can do, or might it be the rootstock? We budded onto cape lemon."
A. The cape lemon rootstock is your major problem. Lemon rootstocks produce big quantities of fruit, but the quality is always poor. Lemon rootstock is for commercial juice production where they want to emphasize quantity. They then mix with smaller amounts of other juices to get the right taste. An advantage of the lemon stock is rapid growth, it being more vigorous than other stock. However, this also results in poor taste. Climate can also cause inferior taste. It would help if the climate were cooler. I would suggest budding onto either Carizzo or sour orange. They may not allow sour orange into the country because it is so susceptible to tristeza. For example, Brazil's citrus industry was wiped out some years ago by tristeza. But it depends a lot on how virulent is the strain in your country. It is so good that I would take the risk and not worry too much about tristeza. My third choice would be Cleopatra mandarin. The disadvantage with it is foot rot. This world-wide problem is caused when workers injure the root while cultivating. It is most susceptible during the first 5 years. The safest thing would be to use a combination of rootstocks. Then it will be unlikely that you will be wiped out.

If you wish to plant some true-to-type seeds I would recommend two varieties: ridge pineapple or what is called "old sweet seedling." By the way, any true-to-type seedling [plant grown from seed that will give fruit like the parent tree] is susceptible to foot rot.

Q. (From Peter van Lonkhuyzen in Haiti.) I have used budwood from some three year old trees that are not bearing fruit yet. Someone told me that by using such young trees my grafted trees will start bearing late and never will give good yields. Is this true?
A. A grafted tree will normally start bearing some fruit within a year. The fact that the parent trees you used were not bearing at three years suggests that they were seedlings. If so, you will have to wait about as long as if you had planted the seed. There is one way you can get some quick budwood. Take budwood from a mature bearing tree and graft onto a rootstock in your area. As soon as this has grown to produce some branches, you can use this to bud other trees. They call this "first generation budwood." However, the second generation of trees should not be used for budding until they have started bearing.

Q. What rootstock should I use that is resistant to both drought and tristeza?
A. Sour orange is drought resistant, but if you want tristeza resistance also I would recommend Carizzo. Of course, even that is only drought resistant to a point. True-to-type seedlings will never tolerate drought as well as the normal rootstocks. I might also mention that a rooted cutting from any variety of citrus will have about half the normal life expectancy of a grafted citrus, due to susceptibility to a range of root diseases.

Q. How is it possible that in some places they have Washington naval trees without thorns while somewhere else the same variety has thorns?
A. There can be some differences in thorniness within a variety. In the one location they must have budded from trees that did not have thorns. You will still have some thorns of course. Alternatively, the thorny ones could be seedlings, as they tend to have more thorns.

I also asked about susceptibility to *Phytophthora* root rot. He said that rough lemon is one of the worst root stocks in regions where *Phytophthora* is a problem. It once was the primary root stock in Florida, but has been totally replaced. All citrus trees are susceptible to *Phytophthora* root rot to some degree. If a workman injures a root and the organism is in the soil, it can enter and damage the tree. It can then kill after a few months or just reduce production. Some trees in a row may become infected and others not. Budwood is not infected.
(https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

ARE THERE DWARF CITRUS TREES? Robert Weaver in Thailand asked us. From Dr. Carl Campbell: Yes, there are dwarfing citrus rootstocks. The research station in Florida has a few. I asked why almost no one is planting them. Carl said it is not that there is a problem so much as that no one knows just what to expect. The risk that in 8 or 9 years the tree might die is too great for large-scale movement to the untested rootstock. (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

GROWING YOUR OWN GRAFTED SUBTROPICAL VARIETIES OF DECIDUOUS FRUIT TREES. Dennis Desmond in Ecuador asked some interesting questions concerning a project to produce 5,000 fruit trees (subtropical varieties of temperate fruit) annually for local farmers. He already has a few apple, peach, pear, plum and apricot trees going that he can use for grafting material. Now he wants to begin growing rootstock [seedlings to which superior varieties will be grafted]. I know a lot of you have similar questions. For example, what kind of apple seed should he buy, where would he get it, what pretreatment is needed, etc. This prompted a call to Dr. Wayne Sherman in the Fruit Crops Department of the University of Florida. A summary of this most interesting conversation follows.

In the States nurseries buy rootstock (very young trees) from specialized companies, usually in Washington and Oregon. Unless a particular name is specified, they most likely were grown from seed collected at cider mills. Dr. Sherman said that the easiest solution in the tropics also gives the best results--simply save seed from the subtropical fruits that are already bearing on your present trees. For example, Anna and Dorsett Golden apples will give better rootstock for a mountainous site in the tropics than would purchased seed taken from a cider mill in the States.

How can one get dwarf trees? He said that this is going to be expensive and hard to get. There is no good history of how they will do in the tropics, although the seedling stock is well adapted.

What about "clonal" propagation where trees are grown from root cuttings? The problem is that every tree will be genetically identical, in contrast to seedling trees which have a lot of genetic variability. If a particular pest comes along that is able to attack one of the trees, it will also successfully attack all the other clonally propagated trees! If trees came from seedlings there would be a much better chance that some would be resistant. For example, wooly aphids could wipe out an entire orchard if it were clonally propagated, but not if the rootstock came from seeds.

What kind of pretreatment is needed? After removing seeds from the apple, wash them. Put 100-500 moist seeds in a brown paper towel, roll the towel up, and place it in a refrigerator at normal refrigerator temperatures (40-50Ã¸F) for a month. Keep the towel moist. After a month start checking to see if seeds are germinating. They will probably start to germinate after about six weeks (longer if you were not starting with seed from the subtropical apples). At that point plant the entire bunch of seeds.

You should likewise save your own seeds from subtropical peaches. Crack the shell and put only the kernel in the moist paper towel. They should be ready to plant in about eight weeks. In three months they will be over two feet tall and are ready to T-bud. Five months later they can be set into the field. (In contrast apple trees must grow a year before grafting and another year before being set into the field.)

At higher elevations you may find a "Spanish" type of cling peach growing. If root knot nematodes are a problem in your area, however, you will have big trouble because peaches are susceptible to this pest. There is a nematode-resistant variety called nemaguard that is used for peach rootstock, but this would have to be purchased from a temperate country (importing a large package of peach seeds will not be easy or cheap). I asked if you could plant a nemaguard seed then in a few years have your own nematode resistant seeds. He doubts that it would ever produce because it requires such a long period of chilling. Clonal propagation of peach trees from the roots is very difficult.

Pears are treated the same as apples, again using any locally available pear seed. Plums are treated the same as peach. However, many prefer to graft plums onto the peach rootstock. Dr. Sherman said that plum seedlings vary so tremendously in vigor that three-fourths of them may not be usable. Apricots can likewise be grafted onto peach rootstock. (Do not graft peaches onto plum or apricot, nor plum to apricot, nor apricot to plum.) (https://cdn.ymaws.com/echocommunity.site-ym.com/resource/resmgr/a_to_z/azch12ge.htm#Table)

DIFFICULTY GERMINATING *PAULOWNIA* TREES? We received many reports that our seed for *Paulownia* trees (no longer in ECHO's seedbank) is not germinating. Recently, "Tree Project News" reported that paulownia is extremely sensitive to shade and requires intensive light for germination and seedling growth. To determine whether light and surface planting were necessary, we undertook a simple trial in our greenhouse to ascertain the viability of our seed and the proper germinating conditions.

Nearly all seeds germinated in all of the experiments. What is different when the seeds are planted at ECHO? We can only guess. One possibility is that people are expecting a much larger seedling. Paulownia seedlings are very small (approximately 2-5 mm across) and can easily be overlooked or mistaken for weeds. The seeds did not germinate for three weeks, a bit longer than most familiar garden seeds. People may be giving up too quickly. Seedlings are exceptionally subject to damping off (being killed by fungus disease). They can probably germinate and die before they are even noticed.

Here is what we did. First we used sterile potting soil, in 6-packs. In one trial the seeds were barely covered with soil, placed in regular lighting, and received watering once per day. The second trial was similar except that the seeds were placed directly on the soil surface and placed in a mist chamber (soil was kept moist