

THE INFLUENCE OF THE CHARACTER OF THE STOCK ON TREE GROWTH IN CITRUS PROPAGATION

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Mr. President, Ladies and Gentlemen:

Why should a paper on a purely citrus subject be presented before the California Avocado Association? Because it is an opportune time for avocado growers to take stock of the subject to be presented and secondarily, because many of you are interested also in citrus culture. As the subject is presented I think you will discover that it is of as much interest to avocado growers as to citrus growers. With this explanation of the subject, I will proceed with the discussion.

Why do some trees in a citrus grove remain dwarfs, or grow slowly and produce few fruits while others grow well and are very fruitful? Why are some groves uniformly composed of good trees while others are composed of trees of various sizes and degrees of fruitfulness. Mr. A. D. Shamel of the U. S. Department of Agriculture has emphasized the relation of the character of the buds used in propagation to this variability in orchards and has rightly urged the importance of choosing buds for propagation from uniformly highly yielding trees of good standard type. Is this all of the story or are other factors involved, which we should know about and guard against in growing citrus trees?

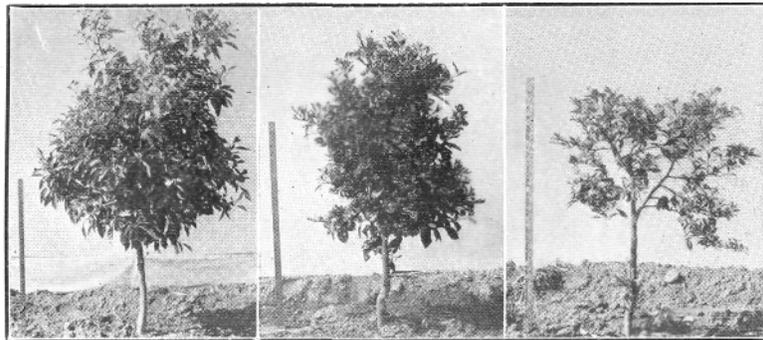


Fig. 2.—Sour orange (C. E. S. No. 628). A good, typical type with vigorous and excellent foliage and branching characters. Selected as a good stock type.

Fig. 3.—Sour orange (C. E. S. No. 625). A type of medium size, also differing from others in foliage and branching characteristics.

Fig. 4.—Sour orange C. E. S. No. 619). A slow-growing dwarf type.



Fig. 1.—Marsh Seedless grapefruit. Average-sized trees chosen from test rows of large, medium and small nursery trees; large on left, medium in center, small on right. Planted in orchard June, 1917, and photographed May, 1919.

It is a well known fact that nursery trees as they are normally grown, when two years old and ready for sale, exhibit great diversity in size, the trunks frequently ranging from $\frac{3}{8}$ inch to $1\frac{1}{2}$ inches in diameter. Does this variation in size of trees of the same age mean anything, or is it purely accidental? All of these trees are ordinarily sold and planted. Probably these differences in size are due to the same or similar causes as those responsible for the differences in size of bearing orchard trees.

A nursery grown at the Citrus Experiment Station for experimental purposes was planned with the idea of producing as uniform trees as possible. The sweet seedling stock used was thus selected when it was planted in the nursery, many of the small trees being discarded. Through the kindness of Mr. Shamel, the buds used for propagation were taken from some of his best record trees of standard type in order to further insure uniformity. Valencia and Washington Navel oranges, Marsh Seedless grapefruit and Eureka lemon were the varieties grown. When this nursery was two years old and ready for orchard planting the trees were found to show the same variations in size of buds that have been referred to as being universally present in ordinary nurseries. Had buds been taken indiscriminately from ordinary trees this variation would have been passed by as normal. As it was, this fact led to a test of the different sizes of trees to determine, if possible, whether they were of any importance in growing an orchard. Eighteen large, eighteen small and eighteen intermediate sized buds of each variety were selected and planted in comparison rows in the variety orchard at the Citrus Experiment Station, Riverside, California. These trees were all dug "bare root" to see that the roots were normal and not injured or diseased. All were normal and thoroughly healthy so far as could be determined. They were planted in the orchard in June, 1917. The severe heat coupled with "bare root" planting injured so many of the Eureka lemons that this variety was eliminated from the experiment. The Navels, Valencias and Marsh Seedless grapefruit stood the transplanting very well and are still growing.

These trees have now been in the orchard $2\frac{1}{2}$ years and are $4\frac{1}{2}$ year old buds. They still retain the same comparative difference in size just as markedly as when they were transferred from the nursery.

To get some indication of the comparative average size of the tops of the different groups, the top diameter of each tree was measured east and west, north and south

and the height from the lowest branch to the top of the foliage. These measurements for each tree were multiplied together to give the volume of the cube that would enclose the top. The averages of these figures for each group in each variety are given in the following table:

	LARGE	INTERMEDIATE	SMALL
Navels	54,174	20,185	12,541
Valencias	29,003	15,606	12,953
Grapefruit	26,343	15,827	10,642

While admittedly such figures are not exact measures of the top volume, they are believed to represent fairly accurately the comparative sizes of the trees in each group.

To what factors could this variation be due, and is it of any importance in citrus propagation? A difference in the soil or in the nutrition available might cause variation in size, but this cannot be the main cause of the variation in size of these trees as they showed the difference in the nursery and continue to show it 2½ years after transplanting into the orchard. In the orchard they are planted close together on uniform soil and are treated alike so the difference cannot be attributed to local soil condition or nutrition.

Is the difference due to the character of the bud union? The buds seem to have healed nicely in all trees used and exhibit no characters that would indicate a difference here.

Is it due to the roots having been injured thus resulting in dwarfing the tree? The roots were all examined when the trees were transplanted and all were found to be healthy and uninjured. Any injury or disease contracted since the trees were transplanted could not be limited to the small tree rows only.

Is it due to the kinds of buds used? All that can be said regarding this is that the buds were carefully selected from trees of known record and standard type. It does not seem that the difference is to be explained in this way although this possibility cannot be entirely eliminated.

The only other factor that is likely to be the cause of the variation is the influence of the stocks used. The sweet orange stock used was merely ordinary sweet orange seedlings grown from unselected seed, the only extra precaution taken being merely to discard the small seedlings when transplanting from the seed bed. About fifteen percent, of the total number of seedlings were discarded at that time. The universal custom pursued at present is to use either sweet, sour, grapefruit, lemon or trifoliolate orange stock without reference to any particular kind within these great groups. Are the variations within the ordinary lots of sweet and sour orange seedlings sufficiently great to be assumed to account for these variations in size of nursery trees? Fortunately some evidence has been secured bearing on this point.

In 1915 the writer, with the help of Mr. W. M. Mertz and Mr. E. E. Thomas, made an examination of one sour orange nursery and selected sixteen seedlings that appeared to show different characters. At the same time in the same nursery four different types

were selected in a bunch of sweet seedlings. A more detailed examination would doubtless have revealed many more types but the only object in view at that time was to add "freaks" to the variety orchard. Buds were cut from each of these seedlings and two sour orange stocks were budded with each type. The trees from these buds are now 4½ years old from the bud and have been set in the variety orchard for 2½ years. All of the types selected present marked differences in size, foliage, character of branching and the like. The good vigorous types in the case of the sour orange selections are five times, or more, larger than the slow growing dwarf types. Two trees out of sixteen of the sour orange types selected have lost the typical aroma of the sour orange, so far as the leaves are concerned. The four types of the sweet orange also differ in similar way in size and foliage characters.

The great extent of this range of variation within the different species is shown equally as well by the large number and range of the named varieties that are grown.

In sweet orange and sour orange seedlings, usually or at least frequently, grown from seed of unknown origin, and coming from different trees, we are not dealing with a homogeneous lot but with lots in which every individual differs from every other individual and yet our policy has uniformly been to use all, good and bad alike, for propagation. Is it any wonder under these conditions that our trees, though grown from the best selected buds should be variable in the groves?

The Eureka lemon on a trifoliolate stock is very markedly dwarfed while Valencias grow to good sized trees. The Florida rough lemon is usually a good stock while the Chinese lemon is commonly recognized as a poor stock. Different reactions on the bud caused by the influence of different stocks are well known to exist. When, therefore, such marked differences are found to exist in our sour and sweet orange seedlings that we are using as stocks, is it any wonder that the budded trees in the nursery, even when selected buds are used, should grow differently and produce large and small trees, and that these differences should continue to exist when the same trees are grown in the orchard?

The evidence now available very strongly points to the conclusion that the differences in size of nursery trees, such as those taken for the experiment outlined, are mainly to be attributed to the different nature of the seedling stocks used. If this is true, and it is entirely in line with the evidence as well as with common sense and judgment, it immediately becomes an element of fundamental importance in citrus propagation.

I would be remiss in caution and duty if I did not call your attention to the fact that one very important link in the chain of evidence is yet lacking, that is, the growing of good buds on known stocks of these various types to prove that certain ones give better growth than others. This evidence, however, is partially supplied by our known experience of the reaction of buds on different stock such as referred to above.

Will the small trees continue to remain small? Certainly the evidence thus far indicates that this is very likely. It's a good bet that they will. Dr. Reed of the Citrus Experiment Station carried out a series of experiments with a considerable number of sunflower plants that has a bearing on this phase of the problem. In this group of sunflowers, exact measurements of height were made of each plant every week from the time it was a few inches high until it reached maturity. The analysis of the data of growth obtained

showed a well marked tendency of the plants to retain their same relative rank as to size throughout the period of growth. Plants which were small at maturity were generally small in the beginning, and those which were large at maturity had a well marked superiority from the start. The evidence indicated that height and vigor of growth were determined not by chance but by some definite inherent factor in the plant itself. The same is doubtless true with citrus seedlings of the various species, such as those used for stocks, and if the cause of the different sized nursery trees is to be attributed primarily to the influence of the stocks as seems probable, then it is also probable that the difference is due to causes inherent in the different stocks and that the same relative rate of growth and size will be maintained in the majority of the plants.

While the evidence is yet incomplete, we are probably justified from what evidence we have, in speculating somewhat as to what this means in our fruit industries. Frequently, almost every tree in an orchard will be a fine good grower and fruiter, giving a uniform orchard. Again, an orchard equally well handled may be very un-uniform, having some good trees, some poor ones and some of intermediate character. This difference could be accounted for by assuming that the good orchard chanced to be from trees grown on stock that happened to come from seeds of good stock trees, or that they had been taken from a nursery where in filling the order of size only the large trees had been dug, which would be the ones naturally of good vigorous stocks. The remaining slower growing trees from such a nursery would ultimately reach the required size and be sold and planted in another orchard which would likely give an uneven orchard with good and bad trees.

Some growers will be inclined at first to think that their experience is contrary to this and that the small tree is more likely to be fruitful, while the largest trees are likely to spend their energy in vegetative growth. They must remember that this experience was gained before buds of selected type were used. Mr. Shamel has demonstrated that some types of our varieties tend to produce rapid growth and little fruit while others produce good growth and are fruitful. The results the writer is explaining, however, were obtained with the use of buds taken from the best fruiting types and it is not likely that this type will be changed materially by the stock other than in size of growth.

If the results of these experiments are correctly interpreted by the writer, it means that our nursery methods in citrus propagation must be materially changed.

(1) We must no longer grow merely sour stock or sweet stock and the like. The process must be carried farther and good stock varieties of sour orange and sweet orange must be discovered and named as stock varieties, and every nurseryman should then use seeds from these varieties known to produce good stocks.

(2) Good policy will doubtless dictate that all small seedlings be discarded when transplanting from the seed bed into the nursery.

(3) In budding a nursery no inferior seedlings found in the nursery should be budded. Doubtless hereafter we should carefully inspect the seedlings just before budding and cut out all inferior ones to save the expense of budding them.

(4) When the budded trees reach the age for transplanting into the permanent orchard only the good, vigorous, growing ones should be used.

The writer assumes that naturally now only buds from trees of known good record and of standard type will be used in propagation. This is already recognized as the only correct and safe policy.

In a long time crop, like citrus fruits, too much care cannot be used in the beginning to insure that the trees planted are worthy of the effort and expense. How much this will mean in the improvement of our citrus orchards cannot now be foretold. That a change in our nursery methods has become necessary I think few will be inclined to question.

This is the first time this material has been presented before a public audience. I was anxious to place it before avocado growers because the principle doubtless applies equally well to the avocado and to the other fruits that are budded and grafted. The avocado industry is just starting. The great avocado groves of the future are yet to be planted. The trees grow large and not many are required to plant an acre. These trees should all be from selected buds and on selected stocks. I have no doubt but that the stock is just as important an element in success as the bud. No factor can be neglected. You must have good varieties, good buds, good stocks, good soil, good culture, good packing to secure good money. It's a good industry.