

The University's Research Program on the Avocado

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Next on the program we will hear from Professor Robert W. Hodgson, of the University of California.

Professor Hodgson: Mr. Chairman, Ladies and Gentlemen: What I propose to do, with your indulgence, is to briefly review the major features of the research program on the avocado, which is underway by the Division of Subtropical Horticulture at the University of California at Los Angeles. I welcome the opportunity to do this for at least two reasons. One of them is the fact that the Division of Subtropical Horticulture is responsible for the horticultural research on the avocado, in which connection your attention is directed to the fact that the work dealing with insect and disease control is conducted by the Citrus Experiment Station, at Riverside. Another reason is the fact that this program is an expanding one and it is desirable that you know just what is contained in this research program.

Our avocado research started in 1930, two years prior to the time the Division was removed to this part of the state, and the investigational work during that period was confined to a study of the flower behavior and pollination requirements of the avocado, with particular reference to the Fuerte variety. This was a natural starting point because a few years back Dr. A. B. Stout, of the New York Botanic Garden, had spent a winter in California and had reported on the rhythmic opening and closing behavior of avocado flowers, which would appear to indicate certain pollination problems. We discontinued this study about a year after we moved down for the reason that it became evident, to us at least, that the avocado does not have important or serious pollination problems in Southern California. In spite of the fact that the flowers do open and close in an interesting and rhythmic fashion, which would indicate the necessity for cross pollination, there is undoubtedly enough lap-over and irregularity to provide for adequate self-pollination.

In the spring of 1933, shortly after we set up in business on the Los Angeles campus, we undertook a study of the bearing behavior of the Fuerte avocado variety with particular reference, of course, to the causes for its irregular and unsatisfactory bearing behavior. This work has consisted primarily in obtaining yield records of as many trees as possible and analyzing these yield records and correlating them with climatic conditions. We believe that the data now at hand establish the major facts concerning the bearing behavior of that variety, which appear to be the following:

FUERTE'S MAJOR BEARING FACTORS

- (1) The Fuerte variety has very marked tendency to alternate bearing, amounting to perfect alternation under certain conditions.
- (2) That the amount of crop produced the previous season determines the bearing capacity for the ensuing season.
- (3) That the bearing capacity is accentuated or minimized by the temperature conditions that obtain during the period of blossom and fruit-setting. The occurrence, two years in succession of favorable or unfavorable temperatures may completely upset the stride of alternation.

FERTILIZATION

In our opinion, these facts have been satisfactorily established, and we now know the nature of the bearing behavior of this variety. But how to control this bearing habit is the problem, and ways and means for so doing are now under study. Among these are fertilization, particularly with reference to the maintenance of high nitrogen and low nitrogen levels, and high phosphate and low phosphate supplies in the soil. Thus far the evidence indicates that high or low nitrogen and high or low phosphate makes no difference so far as bearing behavior is concerned; the treated trees alternate in the same way as do the untreated trees. Indeed there is the suggestion that high nitrogen accentuates the alternation. The high nitrogen trees tend to overbear in the "on" crop years and to bear less in the "off" crop years as compared to the untreated trees. This has been shown to be true of other alternate bearing evergreen fruit trees, notably the olive.

GIRDLING

Another practice under study is girdling to induce bearing in trees that rarely, if ever, produce satisfactory crops, of which, as you well know, are altogether too many. In certain areas not favored climatically, there are fine, vigorous trees, well cared for and of bearing age, whose crops range from nothing at all to fifty fruit or so—trees capable of producing a thousand fruits or more. We have experimented with girdling on such trees and find that it decidedly increases their production from 600 to 1000% or more—but it has to be timed properly. It must be done during the period beginning immediately preceding the start of the blossom and extending up to half way through the blossoming period; from that time on, little or no significant effect is produced. In regions definitely climatically unsuited to Fuerte, not because it is too cold or too hot but because it is too chilly during the blossoming and fruit-setting period, even with girdling we have not been able to increase the yield satisfactorily. The increase has been notable but not sufficient to result in anything more than a light crop. Girdling, therefore, does not promise a solution of the problem.

PRUNING

At the present time we are studying pruning—pruning for a very different purpose from that for which it is ordinarily applied. Our objective is to very greatly reduce the amount of bloom, for as I shall point out in a moment in another connection, the avocado tree may exhaust its reserves in the very heavy bloom which it produces, notably heavier some years than others. We have reason to believe that if there were some practicable way of reducing that drain that might tend to even up the alternation in bearing. The results to date are interesting, in that the pruned trees seem to show less alternation than the control trees, not pruned.

EARLY HARVESTING

We also experimented with early harvesting as a possible means for controlling the bearing behavior and have learned that by removing the fruit sufficiently early, we can very decidedly affect the bearing behavior of individual limbs. However, satisfactory results do not occur unless the limbs in question are isolated from the rest of the tree by girdling. The results obtained by early harvesting from ungirdled limbs and from entire trees have been much less striking, and negative in some cases. The tendency is barely evident but at present we cannot offer positive recommendations concerning the use of this practice.

Our work on early harvesting has been handicapped because of the effects of the recent freeze in the orchards, where our work is underway. Moreover, we have had only one excessively heavy crop during the period we have been working on this subject. During that season and the season which followed, in a number of orchards and several repeated trials, early harvesting of the fruit from girdled limbs permitted them to blossom and bear good crops the next year, whereas similar limbs from which the fruit was harvested late blossomed lightly and matured little or no fruit. We have been able to control blossoming on individual limbs and we have succeeded in separating them as to stride and then bringing them back together in stride, but we have not succeeded in applying these to ungirdled limbs or whole trees.

NO PRACTICAL SOLUTION SEEN

The present evidence, from the work done to date, suggests little likelihood of our finding practicable means for overcoming or controlling the alternate bearing tendency in the avocado. Should that prove to be the case, we shall not have been less successful than investigators studying this same problem with other fruits. So far as I know, nobody has yet shown that alternate bearing in the apple, pear, or plum can be commercially controlled, though much investigational work has been done on the subject.

Bearing this fact in mind, during the past four years we have been on the lookout for outstanding Fuerte trees, with reference to high yield and regularity of production. There are now something like twenty on our list, scattered from one end of the avocado belt to the other. Three years ago we established a plot, under rather unfavorable climatic conditions, in which trees were top-worked to selections representing 10 outstanding

mother trees. The tops bore their first crops this season, and it is interesting and encouraging to note that two of these have excellent crops whereas the others have practically nothing. It is not yet safe to mention these strains, but it may be said that they both seem to trace back to one famous old tree. We are also propagating trees of these selections in our nursery and expect to establish collections in several localities.

STUDYING CHEMICAL COMPOSITIONS

In connection with these studies there have been many questions raised which relate to the chemical composition of the avocado tree and its parts. We have, therefore, done considerable chemical work, perhaps the most interesting of which has been that which relates to the effect on the nitrogen composition of avocado leaves of a number of the practices that have been studied, such as, fertilization, girdling, and blossom and fruit removal. We find that although 40 pounds of actual nitrogen have now been applied to some of our trees, at the rate of ten pounds per year, it has not affected the composition of the leaves or fruit in any respect. We have learned from these studies that a very large part of the total nitrogen contained in the avocado tree occurs in the leaves, and we are using the leaves, therefore, as the organs of the plant most readily available for study, as indicators for what goes on inside the tree.

We have found that girdling avocado limbs reduces the nitrogen supply above the point of girdling, which is interesting because the usual assumption is that nitrogen moves up the plant through the sapwood only. The removal of fruit, whether early or late, has no effect whatever on nitrogen content of the leaves or adjacent limbs. One of our most interesting discoveries is that blossoming very materially reduces the nitrogen content of the leaves. A heavy bloom may reduce the nitrogen in adjoining leaves by 50%. It appears that there is competition for nitrogen in the avocado tree during certain periods—participated in by the blossoms and the leaves—and that the bloom has the advantage. The need for more complete information to serve as a basis for interpretation of some of these responses has led us to undertake a more detailed study of the chemical composition of the avocado tree throughout the entire year. We have, therefore, dug out, bodily, 15 seven year old trees, roots and all, fractionated them, weighed the fractions, sampled them, dried the materials, ground them up and put them in storage for analysis when we can get around to doing it. This will involve a large amount of work.

PROPAGATION EXPERIMENTS

Propagation studies of various kinds have also been undertaken. We are analyzing at the present time data accumulated during the past three seasons on size of seed in relation to size of seedling, budling, and nursery tree. The nursery trees in question were planted in orchard form this summer and eventually we expect to correlate size of nursery tree with yield under orchard conditions. This experiment should provide the answers to such questions as whether large seeds make better seedlings, whether large seedlings make better nursery trees, and whether large nursery trees make better orchard trees.

We have also been studying the possibility of raising trees from cuttings, for the possibility exists that the bearing behavior is influenced by the root-stock and we must follow that question. If we can grow trees on their own roots and they still alternate, we will have eliminated root-stock influence as a consideration in that connection. We have been successful in rooting some cuttings but have failed with others. Cuttings from seedling trees, which are young clones, root fairly readily but those from budded trees of old varieties do not. The new growth promoting substances or hormones have not stimulated root development, in our experiments. The results have been negative.

During recent months the question has been raised as to whether seed from frost-injured fruit could be used for nursery purposes. Not knowing the answer, we have tried to find out. Seed from fruit of different degrees of injury was germinated and we find that even badly damaged fruit gives a germination of better than 50%, and fruit too badly injured to be saleable gives seed which germinates as well as that from uninjured fruit.

ROOTSTOCK EXPERIMENTS

The question of root-stocks enters into our research program in several connections and a brief outline of an experiment now underway may be of interest. It has to do with determining the possible value of root-stock selection in the avocado—whether some rootstocks may be better than others. Generally speaking, while nurserymen have preferences as to root-stock race and variety there is not clear cut evidence of the value of selection within a given horticultural variety. In our experiment there are 17 root-stock progenies represented; 16 of them are of the Mexican horticultural race, and one of them is of unknown parentage, probably a Guatemalan or hybrid. The sixteen Mexican root-stock parents represented are all sisters from one parent, an outstanding tree. Out of 65 sisters from this tree we selected 16 which covered the range of variation. Fifty-two seeds were taken from each and were planted in paper pots, each progeny in a flat, and complete records have been kept of each individual seed, seedling, budding and tree up to the present time. The seedlings were budded to Fuerte and Nabal, the buds of each variety all from the same tree. The nursery trees were planted this summer. We hope this experiment may indicate the nature and importance of the root-stock problem in the avocado.

We are also propagating some double-worked avocado trees—trees budded twice and therefore containing a "sandwich" section—for we want to find out if double working will affect the bearing behavior of the Fuerte variety. We are also trying some avocado relatives as root-stocks just to see if they are compatible and offer commercial promise.

CROSSING VARIETIES MOST LIKELY SOLUTION

That about covers the list of investigations already underway, and we have only one additional line of work which we plan to put into effect within the next year or two—breeding for new and better varieties. This we hope to undertake in a small way. For after all it is a possibility that nothing practicable will be learned about the control of the bearing behavior of Fuerte, and that we will not find in the field strains of that variety that are inherently better in bearing behavior than others. The ultimate solution will likely be

the development by breeding—by crossing varieties of desirable characteristics—of varieties similar to Fuerte in fruit characteristics and like Anaheim or Dickinson in bearing behavior.

It is a pleasure to present this report of progress in our avocado research program and to note that it is an expanding program. Four years ago we had only one investigation underway; at the present time there are five or six. It is also gratifying to me personally to be able to report that my associates have become interested in working on the avocado. There are five in our group, and we all teach and have certain other responsibilities. The amount of time we can give to avocado work is therefore limited, but we feel that we are making progress. While this program became effective only in 1933—four years ago, as evidence of our progress I can cite the publication of some nine papers on different phases of our avocado research to date. It should be understood, however, that for most of the items on our program this is only the beginning. With some, results are already beginning to develop; with others, they will not be available in convincing amount for a decade or more. It is gratifying, however, to be able to confront a group of avocado growers and to report to them on a research program which is oriented around what are believed to be the principal problems of avocado production in Southern California.

QUESTIONS ASKED

Q. I would like to ask Professor Hodgson regarding the pruning method he used to reduce bloom, and whether it increased the yield. What kind of girdling was used?

A. Replying first to the last part of the first question—whether it increased the yield—I would say that actually it reduced both the bloom and the yield. It was a thoroughly impractical kind of pruning, applied only for experimental purposes, and consisted of clipping off all the terminals and half the laterals. It took all day to prune three trees. As to the kind of girdling we used—we have used simple band girdling mainly, removing a narrow strip of bark. We find it heals over in six weeks to two months.

Q. I would like to ask if girdling forces the trees in off bloom very often?

A. The question is whether girdling has forced trees into off-bloom. It hasn't in our experimental work. Our work has been done mainly in one locality where the trees came into bloom in November and continue that way until May. They seem to exhaust themselves, and I have never seen any off-bloom under these conditions.

Q. What would be the effect of applying nitrogen at time you notice the tree putting out excessive bloom—would it have any effect?

A. Apparently it doesn't have any effect on the internal competition for nitrogen. The trees on which we worked were well supplied with nitrogen.