

## How to Overcome the Alternate Bearing of Avocados

**Prof. Robert W. Hodgson**

*Talk given at Avocado Institute, Placentia, March 16th, 1934*

**Judge Halm:** We want to make just a little change in our program. The next speaker will be Prof. Robert W. Hodgson, whom you all know, from the University of California, a good friend of the avocado grower and doing excellent work for the avocado industry. He has given this fruit much attention and study, and has traveled abroad where he has been able to make some comparisons. No doubt he will refer to some of his experiences in foreign countries. It gives me great pleasure to introduce Prof. Hodgson.

**R. W. Hodgson:** Mr. Chairman, Ladies and Gentlemen: You will please excuse me long enough to put two or three charts on the blackboard here. If there is anyone to be criticized or censured for my presence on this program, it is the Farm Advisor of Orange County; he is responsible for it. I told him, when he asked me to take part on the program, that I had nothing new to contribute; that our investigational work on the bearing behavior of avocados had just gotten under way last fall, and that I had talked so much in the past about what we hoped to do and planned to do and what we thought might be responsible for the avocado not bearing satisfactorily, that I really didn't think it would be wise to waste time for me to repeat what I have said in the past. However, he insisted, for Farm Advisors have the habit of being insistent. I know for I used to be one myself. So there was nothing to do but yield. I remembered that I always expected folks to do things when I asked them to.

I am going to put some charts on the board to illustrate the way that avocado trees behave with reference to bearing. Each of the crosses represents a crop. This chart will illustrate the results of our survey done thus far. As we all know, for the last ten years or more one of the major questions has been how to make avocado trees bear regularly. The advertised subject of this talk, "How to Overcome the Alternate Bearing of Avocados," is as a statement somewhat premature.

Possibly many of you did not know that the avocado is an alternate bearer. That was one of the first facts we had to establish. What is the bearing behavior of the avocado? To answer this question required individual tree yield records. These are scarce and difficult to get. Very few growers have gone to the trouble to keep records, for which they are not to be blamed. To do so takes considerable time and costs something. We haven't any bearing plantings in our orchard on the University campus. Our trees are very young yet and necessarily it will be several years before we will get individual tree yield records of value. Fortunately, through the cooperation of members of the Avocado Departments, I have succeeded in obtaining some excellent individual tree yield data.

The tentative conclusions I am about to present (because that is all they are) come from a block of approximately 150 good, bearing Fuerte trees for which I have individual tree yield records for the past six years. I have attempted to analyze these records to get some notion of what is the bearing behavior of the avocado. The trees in this block fall into three principal classes, groups 1, 2 and 3 as shown on the chart. There are approximately 36 of the 147 in the first group, 14 in the second group, and 55 in the third group; the remainder fall mainly in a group similar to class 3 but which have behaved differently for part of the period in question. I have reason for believing that these trees were thrown out of stride by some condition at present unknown. Basically there are therefore three classes of trees in this orchard with reference to bearing behavior the past six years. The last big crop year was that of 1930-31, when there was a heavy crop practically everywhere. In this orchard that season the class two trees—10%—had practically a crop failure, but the trees in class two and three and part of the remainder had good crops. Out of the 147 trees in this block, 71% had a good crop. (Question—How old are the trees?) Answer—The trees are now about 12 years old. For the past five years, classes one and two have alternated in their bearing habit but exactly reverse in stride. Class one trees are now entering an on-crop season as are also those in class three. I venture the assertion that unless something happens between now and May or June this will be a bumper crop year.

You will note that about 10% of the trees (class two) have behaved exactly opposite to the 36 trees (class one) and have been that way every year. For six years these two groups have been in exactly opposite stages. When the trees in class one have been in the on-stage, the trees in class two have been in the off-stage, and vice versa. This is a very interesting horticultural phenomenon—alternate bearing. It is particularly significant to note that the trees in class two exhibited this behavior even in 1930-31 when everything was favorable for heavy cropping. The largest group—class three—started out with a big crop in 1930-31 and haven't had much of a crop since. For the most part they have just dropped off from the average from 30-31, a little less the next year, still less the next year, and last year practically nothing. From the evidence available at this time reason is afforded for believing that in this particular orchard approximately 70% of the trees should have a good crop this year, other things being equal. Of course, much can happen between now and summer.

It seems to me that the behavior here portrayed strongly suggests that the avocado is an alternate bearing fruit tree. There is abundant observational evidence to corroborate this conclusion. There are some interesting things about this alternate bearing behavior. The larger the crop in the on-crop year, the smaller the crop in the off-crop year. In other words, if the peak goes high, then the trough goes low. If you find a tree with a thousand fruits on it in one season, the next there is likely to be nothing, or at most only a few fruits. If the peak does not go so high, then the trough does not go so low. There is a cumulative effect, a carry-over effect, caused by the production of a large crop. The maturing of the large crop does something to the tree which results in an inability to produce a large crop the following year. Sometimes the effect is failure to bloom. I have seen Fuerte trees with a tremendous crop one year, and the next year they didn't bloom at all. Doubtless you have seen the same thing. For the most part, however, the effect seems to be on the period of the bloom and on the vitality of the tree. A heavy crop this season, other things being equal, causes a late and weak bloom next season.

Apparently the tree is lacking in something, probably storage reserves.

This is by no means a brand new phenomenon. Those of you who come from the Northeastern States know that the alternate bearing of apples is the principal problem with certain varieties in certain localities. It is interesting to record the same phenomenon in the evergreen avocado tree. When I first took up this problem, I made as careful an examination of the reports of alternate bearing of apples as I could find, and it rather discouraged me for the reason that nobody seems to have really succeeded in overcoming the alternate bearing of apple varieties. True, there are some varieties of more or less pronounced alternate bearing habit where it has been possible to correct it by pruning and fertilization. The varieties showing it most pronouncedly have not been corrected by any practice except by removing the bloom. Removing the bloom from an apple tree is quite a task; to remove the bloom from an avocado tree would be a real undertaking! I don't believe there is a fruit in existence that has as many flowers as an avocado tree.

Based on previous observations concerning the fluctuating bearing habit of avocado trees, which is not confined to California but also evidenced wherever avocados are grown, and based also on observations made on other fruit trees, particularly citrus trees, we have developed a hypothesis to explain the erratic bearing behavior of the avocado tree. In the first place they exhibit this pronounced alternate bearing habit which appears to be a fixed tendency. This alternation is not perfect but that would hardly be expected of living organisms where there are always exceptions. This seems to be the primary underlying phenomenon. Superimposed on that, however, is the factor of weather conditions during the blooming and setting period. As yet I cannot give you exact correlations on this point nor can I tell you just what may be the specific effects of unfavorable weather. I am making such correlations and we are studying the development of the sex cells in the flower, as well as the temperature requirements for pollen germination and growth.

It is perhaps significant to observe that the seasons when we have good avocado crops seem to be in the seasons when the walnut doesn't do well. In years when the walnut is affected by delayed spring development, the avocado seems to set good crops. We know the cause for delayed spring development winters that are too mild. Apparently mildness of the winter weather is decidedly beneficial in promoting the setting of avocados. Just why, we don't know. It may have to do with the development of the ovule or of the pollen, or the germination of the pollen. We expect to study these points as rapidly as time will permit. There can be no question, however, that mild winter weather is decidedly favorable for fruit-setting in the avocado.

The general situation appears to be about as follows: If it is a season when the trees are in the on-crop stage, a crop is almost certain to set unless we have cold winter weather, unfavorable for setting. But weather conditions, even though unfavorable, only serve to partially reduce the crop—50% or so—when the trees are in the on-crop stage. In years when the trees are in the off-crop stage, however, even the most favorable weather permits of only a light to moderate set, and the most we can hope for is a small to medium crop. It follows then that in years when most of the trees are in the on-crop stage, and in addition, the weather is favorable, we should have a bumper crop. This has been our mildest winter in years, and if this orchard is representative of Fuerte

orchards in general, about 70% of the trees should be in the on-crop stage this year. Those two factors coming together would certainly indicate that we might reasonably expect a big crop. This conclusion corresponds with the limited field observations I have been able to make. This is the hypothesis we have derived from the data at hand. It should be remembered, however, that our studies are just beginning. We may have to completely revise our present ideas.

If the avocado has such a pronounced tendency to alternate bearing, what can we do about it? We don't know. We started last fall some cooperative field experiments in three localities, in which we are trying a variety of things. Some of these are purely empirical practices, the effects of which we are quite unable to predict. We simply don't know. We don't even know the physiology of the citrus tree although it is certain that it is very different from that of the deciduous tree in certain important aspects. As a consequence we are trying some things in a purely mechanical way. One thing we have done, however, is to pair the trees under experimental treatment, in consideration of the fact that the trees are in one or the other of the two stages—either the "on" crop condition or the "off" crop condition. I think that failure to do that is responsible for some of the inconsistent results that growers have obtained in the past. Under these conditions we should get exactly opposite effects from some of the treatments.

There are various treatments that suggest themselves in relation to this problem of alternate bearing. What is it that the tree may exhaust that may cause it to be so weak that it doesn't set a crop? The first thing you might naturally think of is nitrogen. We now have trees treated with nitrogen—ten pounds of actual nitrogen per tree—and if they don't respond there isn't much likelihood of lack of nitrogen being a contributing cause. As yet it is too early to note any evidence of differences. Then, too, not only have we increased the nitrogen supply, we have tried exactly the opposite—reducing the nitrogen supply. We have applied cellulose-cereal straw—so as to tie up the nitrogen supply. Perhaps the factor of importance is a relation between nitrogen and carbohydrates which must exist in the tree some time prior to flowering. We have therefore increased nitrogen in some treatments and in others we have decreased it. Not before the summer and possibly the early fall will we know what the results are.

Pruning is an ancient and often important horticultural operation, so we are trying it. It took about a half day per tree to prune off a third of the flowers at the beginning of the bloom. It was our feeling that possibly the trouble is in the excessive drain on the trees from the unusual amount of bloom. I don't believe that any fruit tree blooms as heavily as the avocado. As you know, the bloom period may last three or four months. How many millions of blossoms an avocado tree bears can only be guessed. The flowers are high in nitrogen content. It is logical therefore to suspect that the heavy drain from the bloom itself might have an appreciable effect. So we have cut off a third of the bloom on several trees, but it is, of course, too early to see any results.

We have also done some girdling, treating the trees at various times but always in pairs so we can compare a girdled limb on an off-stage tree with one on an on-stage tree. We have also tried girdling and the removal of a part of the crop. That is the only treatment where results are already evident. A pair of trees was selected, one in the off-crop stage and the other in the on-crop stage. The latter one had a big crop in 33-34, the former virtually no crop. One should be in the off-crop stage this season and the other should

be in the on-crop stage. We girdled limbs in each of these trees last November and removed the fruit from some of the girdled limbs but not from others. The fruit subsequently softened up and was good; every fruit satisfactory, and was enjoyed by the experimenters. The other girdled limbs were permitted to retain the fruit. It was still there the last time I saw the trees, a week or ten days ago. In one treatment the fruit was removed last November and in the other it was left, but in both the limbs were girdled. On the on-crop tree a pronounced difference has resulted in the two limbs. On the off-crop tree no difference is apparent. We really didn't expect any difference in either of the treatments. The results have surprised us. The branch that had the fruit removed early came into bloom three or four weeks earlier than the rest of the tree.

I can't tell you just what this means, but I can tell you what it suggests. It certainly suggests that letting the fruit stay on the trees late in the season long after it is horticulturally mature, places a severe drain on the reserves of the avocado tree and that the longer the fruit remains on the tree, the less is the likelihood that the next crop will be satisfactory. It suggests that lightening the crop as soon as the fruit reaches a satisfactory stage of maturity may be advisable. These are merely suggestions, however, and not proven facts. The surprising thing about this response is that it is entirely different from that we find reported for other fruit trees. There is no evidence in alternate bearing apple or plum trees of benefit from removing the fruit after the seed has hardened. With these fruits the only effect obtained has resulted from either taking the bloom all off, sometimes accomplished by frost, or removing most of the fruit during the period of setting, long before it matures. In this instance we have a response coming after maturity of the fruit which has decidedly affected the blooming behavior the following spring. We don't know whether these limbs are to fruit this season, however, or whether this response will occur again. It was very obvious this spring, even at a distance. While the rest of the tree had no bloom at all the girdled branch from which the fruit had been removed was in good bloom and it was three weeks or more before the rest of the tree came into bloom. This also suggests that possibly in heavy crop years thinning the fruit may provide a means of evening the crops. At any rate we seem to have a lead, and to one doing experimental work, that is something. It at least supplies suggestions as to treatments that may be helpful.

This is all I am able to report at the present time. We have some work under way and we have obtained an interesting lead which we propose to follow up as rapidly as time and other duties permit. It is merely a lead, however, and we have no recommendations to offer at this time. Perhaps by next fall we will have a better notion of treatments that may be practicable to employ in solving this problem.

Just one additional thing. Obviously to correct this alternate bearing habit will require knowledge, skill and work on the part of the grower. A much simpler solution would be to find a Fuerte strain that bears regularly. It is doubtful whether such exists, but we should at least look for it. So we are on the lookout for and will appreciate your calling our attention to outstanding Fuerte trees that have borne regularly and consistently for a period of years. Of course, in the case of young trees such is possible without it being of much significance. It is trees that are ten or twelve years of age or older, old enough to have gotten into the swing of alternate bearing, that we are interested in. We are establishing a collection of such strains by topworking trees to scions taken from the

most outstanding Fuerte trees we are able to locate, including the two original trees from which all the Fuerte trees have come. We have already run across one rather outstanding tree, promising from both its record and the behavior of its progeny. It would indeed be a simple, easy and most satisfactory solution to the problem to find such a strain.

In conclusion, I would like to stress the point that I am not making any recommendations as to what growers may do to solve this problem. I would suggest, however, that it would be helpful to us if you will undertake the keeping of tree yield records. More data of this sort are needed. Your assistance in being on the lookout for outstanding superior trees, particularly of the Fuerte variety and calling our attention to them will be greatly appreciated. Thank you.

**Question:** I'd like to know what is suitable to use as a tree tag.

**Answer:** We use a painted wooden tag about four inches wide and twelve inches long, suspended in the lower part of the tree on wire.

**Grower:** I know a party who uses waxed paper, four inches wide and six inches long and hangs it on the limb. You can write with a blue pencil on that paper.

**Grower:** We find zinc tags successful. You can write on zinc with a lead-pencil and it never comes off—some we have had as long as ten years.

**Question:** Please explain your method of girdling the limb.

**Prof. Hodgson:** We simply remove a strip of bark about a quarter of an inch wide running around the branch. Some use spiral girdling so as to prevent complete separation.

**J. B. Brown:** I have a suggestion concerning the tree tag. There can be purchased a sheet celluloid which is used by map makers for field work. Sheets are about 24 by 30 inches, and not expensive and thick enough to withstand any action of the wind. It is something you can write on very readily with a pencil and will not come off—sheet celluloid.

**Question:** Do you have any observations on whether or not honey bees working freely have any effect on fruit set?

**Prof. Hodgson:** I had intended to say a word or two about that. That is one of the various theories to account for the failure of trees to bear. I have seen cases where the growers attributed their good crops to the activities of honey bees and I have seen right alongside, trees that had just as many honey bees and had no crop. I have made a special effort to correlate flower behavior and insect activity by taking weekly observations. In the first place I find that on practically all varieties I have observed there is plenty of overlapping of the first stage opening and the second for cross pollination. I have further observed that the bees are very active even though the weather may not be bright and warm. I have not yet seen a time, excepting for rainy periods, when the bees were not active. I have also seen flowers that had closed, visited by bees. The bees will go over these blossoms, particularly after the flowers have closed for the second time—at the second opening the pollen is discharged—and

push them wide open and go after the pollen. The indications are that this problem is little, if any, related to lack of pollination. I have seen one or two cases, however, of trees surrounded by other varieties or tops of trees where a seedling shoot or two had been permitted to grow, where the amount of crop suggested that there might be some benefit from cross pollination. The evidence in California is overwhelming in suggesting that lack of cross pollination or lack of insect activity has very little to do with the problem.

**Question:** I'd like to give my experience on leaving the fruit on the tree. We had two trees at Rancho Santa Fe which bore very heavy crops. On one tree we let the fruit hang from two to four months after maturity. On the other, we picked the fruit off. Where we left the fruit on, we had no following crop, and on the other where we picked early at the proper time, the crop was fairly liberal.

**Prof Hodgson:** That corresponds exactly with our observation.

**Question:** Is the physical condition of those three groups the same?

**Prof. Hodgson:** They are all in one block, side by side, under the same conditions.

**Question:** Another question—I have heard it said that experimental work on the avocado has been curtailed due to lack of funds.

**Prof. Hodgson:** If we had enough money to put on another assistant, we could get a lot more work done.

**Question:** We have been forced to take the fruit off our trees early due to thieves, and we take them off just as soon as mature, and I have failed to see where that has increased succeeding crops. We took all the fruit off.

**Judge Halm:** There are a lot of things we ought to look into which could be proved by successful records. We have been greatly interested in this talk and I am sure you can see what study and work is required to arrive at any results. Do not forget the suggestion to give Prof. Hodgson information on any outstanding Fuerte trees. I am sure he will be glad to get it.