WHERE DO WE GO FROM HERE? ¹

JAMES T. GRIFFITHS
Lyons Fertilizer Co., Winter Haven

During the past two years I have had an opportunity to observe citrus insect control from an angle entirely new to me. These observations have placed me in a position where some soul-searching has been in order. I want to discuss these observations, point out some pertinent facts, and attempt in a small way at least to direct our thinking along slightly different lines than many of us have pursued in the past. While my remarks will be confined to citrus, I believe that citrus may well serve as an example for some crops grown under other circumstances.

Today, the citrus industry is in the position of having one or more chemicals available for the control of all our citrus insects and mites. The power sprayers which are available are capable of giving thorough and adequate coverage. Savings are being affected by the use of concentrated sprays. I wish to begin my discussion by raising two questions. What is the most economical way to control citrus pests? Is it possible that when applying sulfur we spray too thoroughly and use too much material?

One point should always be foremost. Insect or mite control must be judged not by the cost per box, but in the final analysis, by the growers' net profits. The cost of an individual application is not the important one, but, rather, the cost of the program for the year, as compared with the results obtained.

SPRAY VS. NO SPRAY

There are four major topics which I wish to discuss. The first one is concerned with the type of results obtained from complete spray programs when compared with no sprays or dusts at all. Accurate comparisons are difficult, if not impossible, to attain in commercial operations. The grower who reduces his spray program usually reduces his fertilizer program, and, thus, results are not comparable. Since about 1940, there have been two unsprayed plots of grapefruit at the Citrus Experiment Station at Lake Alfred. Up to two years ago these

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trees had produced at least one-half box per tree per year more than the supposedly properly sprayed trees about them. When this became known to me in 1947, I set up two experiments to determine if this phenomenon was real. The first four years of these experiments were reported by Griffiths & Thompson. Unfortunately, the trees were not uniform in one experiment, and the smallest trees in the grove made up the untreated plots. Here, actual yields were less, but trends were identical. That is, sprayed and unsprayed tree yields increased or decreased in approximately the same proportion each year. In the second experiment, trees were uniform and yields from the unsprayed plots were just as good or better than from the completely sprayed ones.

Similar experiments on oranges have run fewer years and are not as conclusive, but the trends on yields are similar.

There has been a definite difference in tree condition between the two sets of plots. The unsprayed trees have usually defoliated in the winter as the result of greasy spot. In spite of this, evidence that total yields were affected is not present. However, it is probable that the defoliation resulted in more late bloom fruit.

So far as insects were concerned, scales were never a major problem in the unsprayed plots, and there were actually fewer purple and red scales on the unsprayed fruit at picking time than on fruit where sprays had been applied.

Purple mites were no problem where they were not controlled, but six spotted mites caused injury in some years.

Internal quality was not reduced by eliminating all sprays and dusts. In fact, solids were usually better from the unsprayed plots.

I do not mean to stand here today and suggest that the elimination of all sprays and dusts is either desirable or practical, although this may be the case. I do believe that the results obtained in these plots cast some doubt upon the hypothesis that the use of sprays and dusts necessarily increase yields on citrus in Florida.

**Spray Residues**

Much has been said and written concerning the effects of spray and dust residues on citrus. In collaboration with Fisher (1950a, 1950b) and Thompson (1950), I have had opportunity to study several aspects of this problem. Results of these experiments and general observations have led me to these con-
clusions. Pound for pound of residue, copper and zinc result in greater insect and mite increases than sulfur. In actual grove practice the frequency of sulfur application causes greater increases of both scales and purple mites. There can be little doubt that the regular and intensive use of sulfur is a major factor in the increased insect and mite problems following these applications.

It is probable that every time a spray or dust is applied some undesirable results are obtained, because of a reduction in the effectiveness of the biological checks on pest populations. From the standpoint of biological control it appears to be desirable to work toward reduced spray programs, but the elimination of zinc and copper by many growers has produced very little effect upon the necessity for insect and mite control. This emphasizes the fact that sulfur is often a major cause of later excessive insect and mite infestations. This raises a question which needs considerable study before an adequate answer is found. How much sulfur is necessary?

DUSTING VS. SPRAYING

In 1952, Griffiths, Stearns, and Thompson summarized three years results when dusts were compared with sprays for the application of sulfur. In this work, relatively ideal dusting conditions were attained. Although the trees involved would usually have been thought of as 15 gallon trees, only 10 gallons, or 1 pound of sulfur per tree, were applied in most instances. Minimal amounts were used in an effort to demonstrate differences in the methods of application. However, there was no practical difference, in terms of fruit grade, between the two methods of application, but more scales were present on fruit from the sprayed plots.

Another factor which was discussed very little in the original paper dealt with differences in speed of the machines at the time of application. Although comparisons of speed were made in at least six instances, differences in rust mite control could not be demonstrated.

I believe we will all agree that dusting is less thorough and is more apt to result in failure. In spite of this, there are many groves in the state that are dusted only two or three times a year and rarely, if ever, have a scalicide applied. These groves usually escape with little or no rust mite injury.
Similarly, if one goes into some of the old citrus producing areas of the state, it may be readily noted that the growers use low gallonage per tree, spray less often, and use boom type sprayers at relatively rapid speeds. In spite of this, these growers produce excellent quality fruit that is most acceptable in fresh fruit channels. These facts suggest that it may be possible and desirable to minimize the use of sulfur in all groves on the basis of insect and mite control.

**Greasy Spot and Defoliation**

During the past two winters, groves, particularly in the Ridge Section, have suffered very severe defoliation. While purple mites may have been a factor in some instances, the primary cause associated with the defoliation was greasy spot (Thompson, 1948). I fully realize that many growers and some production men still insist that rust mites are not the cause of this condition. In my own experience I have yet to find greasy spot a problem in any grove when rust mites were never allowed to reach infestations higher than 15-25% of the fruit infested. Other insects and mites can cause greasy spot, and it is always possible that some mite, associated with rust mites, and also controlled by sulfur is the real culprit, but this theory is certainly open to question.

I wholeheartedly agree that there is more to greasy spot than just rust mite feeding. Tanaka and Yamada, Japanese workers, described a similar condition and claimed that it was caused by a fungus which entered at the site of the stomata. Miss Fran Fisher has been working along this line in Florida. I have seen numerous instances where a great many rust mites produced little or no injury to fruit or greasy spot on foliage. Similarly, there are many cases where injury is severe, and only a relatively few mites were present. I will venture an opinion here, that before all is said and done, it will be shown that greasy spot and fruit injury are only indirectly caused by rust mite feeding and that the real cause is a secondary invader such as a fungus, bacterium, or the like. Further, I strongly suspect that the stomata are more closely associated with late rust mite injury to fruit than are the oil cells.

In any case, greasy spot defoliation as it has appeared in the field is often associated with small leaves in the tops of the tree and a failure of the tree to produce satisfactory growth in the top. One school of thought has held that this is simply a
failure to get good coverage with sprays. At the present time I cannot agree with this.

I could name several caretakers who are notorious for poor spray jobs, but who have had few greasy spot troubles. On the other hand, some of the worst affected groves have been on good spray programs, and coverage has been as good as can be obtained with present day equipment.

In this connection I would like to cite another example. Last winter, in a grapefruit grove where trees were being cut off for top working, I made the following observations. These trees had not been sprayed or dusted with sulfur since the preceding June, but rust mites had been common throughout most of the summer and fall. Although there was practically no greasy spot at the bottom of the tree, the tops had a fair amount. This certainly suggests here that the differential should not be attributed to spray coverage.

As I have outlined above, we are faced with certain incontrovertible facts:

1. Citrus can be raised without sprays or dusts and it will be a satisfactory product for cannery use.

2. Almost all insecticides, fungicides, and nutritional sprays adversely affect insect and mite control. Of these, sulfur is the major offender in actual practice.

3. Many growers are obtaining good results in the field with minimal amounts of sulfur and often with relatively poor coverage.

4. In spite of an effort to do a good job by some growers in the Ridge Area, greasy spot is a very real problem to them. It is so real that it sometimes appears that excessive spray is more a factor than inadequate coverage.

There is a spectre which haunts my dreams. It is that some day we will be spraying here as they do in California. They have excellent spray machines, use insecticides early and often, and have more bug troubles than ever before. Is it not possible that we may be going in the same direction? Certainly, I believe in progress, but progress for citrus is measured by more boxes of better quality fruit. If this can be accomplished by decreasing the use of some spray materials, that is real progress.

I once preached long and loud that thorough and heavy applications of sulfur were more desirable. I am now sitting down to a repast of untasty crow and suggesting that this was wrong. I believe that the problem of adequacy should be thor-
oughly explored and I suggest that we may well find that a little sulfur goes a long way, and that it need not be applied as carefully as we have previously believed.

If this theory proves sound, we are on the threshold of some interesting possibilities. I have long advocated a close tie-in between chemical control measures and applied ecology and biological control. By expanding studies in these fields it may be possible to curtail some other spray costs. Similarly, cooperation between the pathologist, horticulturist, and entomologist can lead in the same direction.

The ideas which I present today have been formulating over the last several years. I sincerely believe we should re-examine and re-appraise our present situation. Not more and more spraying, but more intelligent spraying will be an answer to our problems. We have the insecticides and the spray equipment. We need to know for sure how much material to use per tree; how often it should be applied; and how well it should be dispersed over the trees.

There will still be large quantities of insecticides to sell, but a more judicious application will benefit the grower and, in turn, his spray material supplier. What is good for the grower is good for all of us!

LITERATURE CITED


Griffiths, J. T., and F. E. Fisher. 1950b. Residues on citrus trees in Florida: changes in purple scale and rust mite populations following the use of various spray materials. Jour. Econ. Ent. 43: 298-305.


