Strip-treatment with Chemicals

satisfactory commercial control achieved in orange orchard program designed to conserve natural enemies of citrus pests

Paul DeBach and John Landi

Based on results of an eight-year study, a 12-month alternation strip-treatment seems to be a feasible control program throughout Orange County areas where purple scale—*Lepidosaphes beckii* (Newm.)—is the primary pest on oranges.

The oriental purple scale parasite—*Aphytis lepidosaphes* Comp.—does not produce completely satisfactory biological control of the purple scale, but it does substantially retard the rate of increase. Therefore, chemical control treatments must be used.

In citrus, as in most crops—after major and repeated applications of insecticides over long periods of time—it is necessary to determine whether the maximum conservation of natural enemies of citrus pests is obtained. Such a determination involves a study of what happens when no pesticides are applied. The study is limited to small test plots that must be observed for a period long enough to attain an adequate balance between the pests and natural enemies. All pests normally treated with insecticides may not be as bad as previously thought because certain capable natural enemies of one pest may have been suppressed by treatment for another pest. In the case of citrus, ants must be controlled to obtain maximum natural enemy effectiveness. However, ant-control chemicals are put on the ground—not the trees—and do not interfere with natural enemies on the trees.

Investigations of this nature were carried out in various untreated study plots on Valencia orange trees in Orange County beginning in 1948. During the next few years these studies showed that most so-called pests were not so serious as might have been indicated by observations made in some regularly treated orange groves.

The principal exception was the purple scale, which lacked effective natural enemies and usually became serious in the absence of chemical treatment. The oriental purple scale parasite was introduced to California in 1949 and its potential effectiveness was uncertain at the beginning of the studies. However, at present, the parasite is generally established throughout Orange County.

Other pests, more or less commonly treated with insecticides, became less evident in the untreated study plots. These pests included the citrus red mite, *Panonychus citri* (McG.), the black scale, *Saissetia oleae* Bern., the California red scale, *Aonidiella aurantii* (Mask.), the orange worms *Argyrotaenia citrana* (Fern.), *Pyroderces rileyi* (Walsh.), and *Holcocera iceryaella* Riley, the mealybugs *Pseudococcus maritimus* (Ehr.) and *P. longispinus* (Targioni), and the aphids *Aphis spiraecola* Patch and *Toxoptera aurantii* (Fonsc.). The cottony-cushion scale, *Icerya purchasi* (Mask.), soft brown scale, *Coccus hesperidum* Linnaeus, and the citrophilus mealybug, *Pseudococcus gahani* Green, remained under good biological control. All of these pests are attacked by effective natural enemies.

If purple scale could be controlled by use of an insecticide that would not appreciably upset the natural enemies of the other pests present, an over-all pest control program might be improved and costs reduced.

Several possibilities for the development of an integrated chemical-biological control program in orange groves were considered. All were based on the concept of leaving unharmed in a grove an adequate reservoir of natural enemies of the entire faunal complex while controlling the purple scale chemically. The most practical possibility seemed to be periodic strip-treatment applied on a predetermined schedule of spraying or skipping alternate tree rows or pairs of rows. By using such a pattern, untreated reservoirs of natural enemies would always be left in a grove.

First Trials, 1951–55

Two trial plots of approximately 10 acres each were established in Valencia groves in Orange County. Each plot was divided systematically on a map into alternate pairs of rows which would be treated at six-month intervals—spring and fall—with oil spray. This would always leave an untreated row next to a treated row so that natural enemies could rapidly reinoculate the treated rows.

Oil spray was chosen for testing in this program because it leaves no long-term toxic residue, its drift-effect on natural enemies is not great, and it has proven satisfactory in controlling purple scale in the area. It was assumed that an oil spray would give satisfactory control of purple scale for a period no longer than 18 months.

To evaluate the control obtained from the strip-treatment pattern of spraying, purple scale population density surveys were made each spring and fall prior to treatment. The surveys were based on a careful examination and rating of each tree in the two test plots. In addition, monthly observations and ratings were recorded denoting the effects, if any, of the staggered, alternate-row treatments on the purple scale-parasite relationship. Other pests in the groves were rated also to determine whether or not those pests with effective natural enemies were upset by the program. The test plots were visually compared periodically with adjacent plots receiving more or less standard over-all spray treatments.

In both test groves purple scale and citrus red mite were the most serious pests during the years before the studies were started. Other pests—which are or have been serious problems on citrus in some districts and are potential pests in this area—including the California red scale, black scale, soft brown scale, cottony-cushion scale, citrus aphids, orange worms, and mealybugs were present in the test groves. During the 1951–55 study period these insects were usually held in check by natural enemies, although the citrus red mite and the mealybugs—particularly Baker's mealybug—became fairly common on occasion but were reduced by parasites and predators. Initially, heavier purple scale and mealybug infestations, as well as other pest problems, were evident in one test plot along a west border windbreak of eucalyptus trees as compared with the central and eastern portions of the grove. That tendency continued, although to a much lesser extent, during the strip-treatment period. The afternoon shade, with lower temperatures and higher humidities close to the windbreak, may have favored pest increase over that of natural enemies.

By the fall of 1955 it was evident that these strip-treatment trials were successful. Purple scale had remained under good commercial control for the four-year test period, and populations of various potential pests showed no significant increases or differences that could be

correlated with the use of strip-treatment. Citrus red mite populations were generally lower than in adjacent regularly treated areas, and mealybugs were less evident throughout the groves than pretest surveys had indicated. The natural enemies of the California red and black scales were common throughout both plots and proved to be effective in maintaining a satisfactory degree of biological control.

Second Trials, 1956–59

Information accumulated during 1951–55 indicated modification of the strip-treatment schedule would improve the control program.

The desirability of modification hinged on the findings of other researchers that spring oil-spray treatments on Valencias in Orange County may be detrimental to fruit quality and production. Also, it proved difficult to maintain and coordinate a program of treating alternate pairs of rows at six-month intervals. Financial savings to the grower could be improved because—even though one-third less spray material was applied per year—the pest-control operator had to go through the grove twice a year.

Furthermore, it was now known that purple scale could go untreated for a full 18 months under a strip-treatment program; the purple scale parasite had become established during the 1951–55 test period and was slowing down the rate of purple scale increase in Orange County. Therefore, a 24-month period between treatments might be feasible under strip-treatment, which would mean treatment of every other pair of rows once a year—only one-half the grove—in the fall. Pest-control costs would be reduced by at least 50% and the spring oil spray treatments eliminated.

Early in 1956 a modified program was initiated for the same Valencia test plots used in the first trials. The spring oil treatment was omitted and each fall every other pair of tree rows were to be treated. Each successive year the rows untreated the year before would be treated. A third 10-acre test plot near Irvine was established under the new modified program early in 1956.

In the process of converting the original strip-treatment plots from a six-month to a 12-month alternation program, certain rows had to go untreated for a longer time than would have occurred on the original schedule. In one plot a considerable citrus red mite attack occurred in those particular rows the first season. Barring that one incident, the two original alternate strip-treatment plots continued under satisfactory commercial control of all pests under the 12-month alternation program until April 1959 when the test was terminated.

The new plot near Irvine had received regular annual treatments and had a heavy black-scale infestation. There was evidence of previous citrus red mite damage and all the usual insect species were present. Under the 12-month alternation strip-treatment program the black-scale infestation decreased satisfactorily within one year and all other pests remained under good commercial control until April 1959.

The purple scale parasite accounted for considerable mortality through parasitization and host-feeding on scale in the untreated rows as well as on scale that may have survived in the treated rows. Thus the parasite was instrumental in the success of the strip-treatment program. Other potential pests in the groves studied were held in check by effective natural control factors, primarily parasites and predators.

The effectiveness of natural enemies—in any biological-control program—is seriously inhibited by even moderate ant populations. Sustained control of ants is essential.

Paul DeBach is Entomologist in Biological Control, University of California, Riverside.

John Landi is Laboratory Technician in Biological Control, University of California, Riverside.

The above progress report is based on Research Project No. H-1493.