their backs twitching when disturbed. Turned right side up, the larger one slowly burrowed into the food but the smaller seemed unable to burrow. It is likely that they had eaten some food during the 7 months.

Another 25 larvae from the same stock were put into the drawer with coarse lindane. The effect of the poison was more rapid than it had been on the first group. In 6 days most were dead or paralysed and 11 showed movement under 600 to 900 f.c.; one larva seemed stimulated and crawled slowly and incessantly; in 18 days this was the only survivor and it finally died on the 49th day.

These experiments show that 1 gram of lindane scattered on the floor of a drawer of insects will immobilise and eventually kill dermestid larvae and should prevent others from becoming established. One ounce of lindane will treat 28 drawers for a year.

BACKGROUND FOR INTEGRATED SPRAYING IN THE ORCHARDS OF BRITISH COLUMBIA

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The practical meaning of integrated spraying is the production of a maximum crop of high quality fruit with a minimum of pesticides. In controlling our orchard pests the idea is to work with Nature as closely as we can rather than to disregard her by relying blindly on preventive spraying and "shotgun" spray chemicals. The ultimate objective is to improve our competitive position, and stay in business.

In 1944 Country Life in British Columbia (28:6, 5) carried an unorthodox item on orchard pest control. Titled, "Is it advisable to spray for the three types of mites in B.C. orchards?", the article was a forerunner of a number of others, published elsewhere, that are helping to put orchard pest control on a logical basis. That early item drew attention to the importance of natural factors in controlling orchard pests. It pointed out that when a spray treatment kills beneficial species as well as pest species, it may, in the long run, do more harm than good. In local orchard circles the article aroused brief speculation. Then this entomological firecracker quietly fizzed out. Like the American Austin it was ahead of its time.

But, during the intervening years, things have been happening in the entomological world. In 1946 Pickett, Patterson, Stultz and Lord (Scientific Agriculture 26:11) published the first of a series of articles dealing with the influence of spray programs on the fauna of apple orchards in Nova Scotia. Their well documented work aroused considerable discussion. It stimulated inquiry in various other fruit growing areas; notably in Holland, Belgium, Great Britain and California. The outcome has been the firm realization that we cannot hope to subdue our orchard pests by any one method of control; and, in particular, that chemical control should be applied with caution. During the last 10 or 12 years this note of caution has been heavily underscored by the development of resistance to pesticides in a wide variety of noxious insects and mites.

For many years it had been known that insects might become resistant to such very different inorganic

preparations as acid lead arsenate and lime sulphur. But only in the 'fifties, after the introduction of DDT and its many successors, did the full significance of resistance become clearly evident. The problem is widespread; all over the world pesticide-resistant insects, mites and ticks are evolving rapidly under the stimulus of chemical selection. Synthetic molecules of high initial effectiveness become useless one after another. The chemists are hard put to keep pace with the ceaseless change. Some entomologists claim that a pesticide used at low dosage may lead more quickly to the segregation of a resistant strain of pest than at high dosage. Other entomologists incline to the opposite view. We have to balance uncertainty there, against certainty otherwise, that the low dosage is preferable.

The man on the land may not realize that the way in which he uses a pesticide can have a bearing on its period of usefulness. Apart from being a waste of money the needlessly frequent use of a pesticide may be an open invitation to chemical selection. The more often a pest population is exposed to a pesticide the sooner will a resistant strain be segregated. And there is another matter to think about. Some pesticides are highly toxic to certain pests, but only moderately toxic to certain beneficial species. Heavily applied these compounds may be indiscriminately lethal. But, if used at a dosage just high enough to kill pests, they may spare the beneficial species.

The careful use of pesticides yields yet another, and very different dividend. The lower the dosage of pesticide the lower the spray residue on the fruit at harvest. The consumer is becoming increasingly uneasy about spray residues, and understandably so. There is no point in giving any justification for public concern. That brings us to a modern best-seller. Rachel Carson's book, Silent Spring (Houghton & Mifflin, Boston, 1962), is already one of the most quoted, and most editorialized books of our time. In lovely, flowing English it evokes a grisly spectre. With spine-chilling examples of death already done, it warns of the mass poisoning of our environment by sinister pesticides synthesized with diabolical skill in the laboratories of modern merchants of death. To millions unacquainted with the facts (most consumers) Silent Spring's impressively technical list of references, and its frequent dropping of names in science and medicine, greatly emphasize its credibility. And of special concern to fruit growers, spray residue, writ large throughout the book, becomes a term to rank with that modern abomination, atomic fallout.

Regardless of the fact that Silent Spring is woefully biased, and in fact misleading, our methods of pest control will assuredly be modified by spray residues, the needless destruction of beneficial, or aesthetically desirable organisms, and the development of pesticide resistance. That is why, as the author of the long-defunct Country Life article that suggested more thought and less spray, I think the time has come for action.

In 1961 we of the Summerland Research Station began a long-term experiment in a commercial orchard at Summerland. The purpose was primarily to demonstrate the influence of various dormant sprays on the abundance of pests, predators, and parasites. Following the application of the dormant sprays (one plot received no dormant spray) we applied foliage sprays only when pest-induced, commercial loss was clearly imminent, and used selective pesticides whenever possible. During the

second year the per-acre outlay for pesticides in the owner-sprayed part of the orchard (sprayed "according to the book") was about 25 dollars more than the outlay in the experimental block. Yet the owner-sprayed trees were no healthier, and the crop returns no larger. And equally important, the owner, a very competent operator, had a more efficient sprayer than that employed in the experimental block.

This demonstration of savings in operational costs shows what can be done with integrated spraying. But it does not go far enough. The orchard in question is in a cool part of the Summerland district. Pest control there is considerably less difficult than in, for example, the hotter and drier Oliver-Osoyoos district. What we need now is an extension of this sort of thing into each major fruit producing area of the B.C. interior; and that is what we are planning.

Working together, the Horticultural Branch of the British Columbia Department of Agriculture, and the Summerland Research Station of the Canada Department of Agriculture are arranging comprehensive demonstrations. Adjoining blocks of mature pear trees and mature apple trees (except for a third of each treated with dormant oil, and a third treated with dormant lime sulphur), will be sprayed only when spraying is unquestionably necessary. That will hold whether against insects, mites, or fungus diseases. Preference will be given to selective pesticides. Indiscriminate compounds, such as DDT, will be avoided if at all possible. By doing all we can to ensure the survival of predatory and parasitic species, and by enlisting the aid of the weather whenever the weather can help us we shall aim for the maximum reduction of pests by natural control agencies, and hence the minimum application of chemical control measures. In the Okanagan Valley there will be demonstration blocks of from 3 to 5 acres each at Oliver, Summerland, Kelowna and Vernon. In the Similkameen Valley there will be a block at Keremeos.

We shall have to ensure that the spraying technique is adequate, and that the spray chemicals are deposited in the amounts intended. To that end foliage and fruits will be sampled from the tops and bottoms of the trees in each orchard. The samples will then be analyzed in the chemical laboratory.

Of the many interrelated forms of life that exist in British Columbia orchards, we know relatively little. Until fairly recently the resources of the Entomology Laboratory at Summerland had to be largely devoted to the "brushfire" type of research—the day-to-day job of keeping abreast of the codling moth and its associated problem makers, the orchard mites. With the codling moth problem contained for the moment, thanks to the two modern synthetic preparations Guthion and Sevin, we can now tackle the broader issues. Some of these issues are inherent in the proposed project on integrated pest control. As long as the project is in operation (at least 5 years) we shall assess the rise and fall of pest species, parasites, and predators. This ecological work is fundamental; without it we are, in a sense, without a compass. In making our pest control recommendations we shall eventually be on more solid ground.

Let us now consider where we stand with our present spray practice. Although perhaps unnoticed by many fruit growers, the use of pesticides in the British Columbia fruit industry has been progressively put on a more rational basis over the last 13 years. We took the first step in 1949 with the

introduction of low-volume (concentrate) spraying, a technique in which our industry is a recognized leader. At once the growers were able to reduce quite substantially the per-acre quantities of pesticides. The next step was in 1960 when we further reduced the dosages of pesticides. After that date the recommended amounts presupposed good equipment, properly operated (minimum dosages), rather than as previously, poor equipment, poorly operated (maximum dosages). The latter procedure is still followed in many other fruit growing areas. And finally, by undertaking the demonstration of integrated spraying, we are preparing to take the third step. When we have shown the wisdom of spraying only when spraying is clearly necessary, instead of as a just-in-case preventive measure, we shall have reduced the use of pesticides to an absolute minimum; and that will be a good thing. But none of us, research people or fruit growers, can afford to forget that the very survival of the fruit industry still depends on pesticides.

The next job will be to develop radically new pest control techniques. The autocidal (sterile male) project for controlling the codling moth, that has been under way at the Summerland Research Station since 1956, represents such a technique. Although this new method of control looks more and more promising as the work goes on, it is still some years from practical application even if all continues to go well.

We plan to follow the demonstrations of integrated spraying with the preparation and distribution of a grower's manual to illustrate clearly the essentials of the procedure. The manual, a loose-leaf publication in full color, would be used in conjunction with the annually-revised spray recommendations. Primarily a pictorial representation of symptoms of pest infestation, and disease infection, rather than of the pests or disease organisms themselves, it would illustrate the stage of damage, or pest abundance, at which spraying becomes necessary. It would also carry illustrations of the most important agents of biological control.

Integrated control requires that pests be associated with the symptoms of their attack. For that reason certain pests such as the European red mite and the McDaniel mite, and their eggs, would likewise be illustrated. The manual would also carry full-color illustrations of symptoms of the various mineral deficiencies that may be found in British Columbia orchards. Sometimes such symptoms are confused with pest injury, or with disease symptoms.

No deciduous fruit industry has yet been provided with a manual of the type that we propose. The reasons, doubtless, are that the best of color reproduction, which is what we would need, is expensive; and it necessitates superior photography. But, if our demonstrations of integrated spraying should prove successful, preparation of the manual will be such an obvious step that the growers themselves will insist on it. That is why, in anticipation of success, the Research Station photographer will get on with the job this year.