Rapid progress is being made in the effective and economical control of the important orchard pests. Government agencies and chemical companies are developing a growing number of new and effective insecticides. The situation is quite different from that of the first 25 years of the century, when fruit growers had a limited and rather rigid list of insecticides. By that time lead arsenate had largely replaced other arsenticls for the control of the codling moth, plum curculio, and other chewing insects. Lime-sulfur and mineral-oil sprays were used during the winter for scale insects. Kerosene emulsion, nicotine sulfate, or soap was used to check aphids and other soft-bodied insects. Citrus growers used sulfur, mineral-oil sprays, and hydrocyanic acid fumigation under tents. Paradichlorobenzene was effective in controlling the peach-tree borer. Those insecticides were almost the entire list of materials available for general use in the orchard.

The second 25 years of the century is witnessing the introduction of many new insecticides for use in orchards. From 1925 to 1935 perhaps the chief addition was cryolite, several million pounds of which are now used annually in the Northwest for codling moth control. In 1925, growers began to use the highly refined “white” or “summer” oils for spraying fruit trees in foliage. These oils are less injurious to plant tissue than oils of less refinement. They are used as contact sprays for scale and certain other insects, and as stickers or deposit builders for lead arsenate and other stomach poisons.

Many of the new materials that are now appearing are the reward of long and extensive efforts to find a suitable material to replace lead arsenate to control the codling moth. Lead arsenate is still standard in most areas but it does not always give adequate control. It often injures
the trees, and results in excessive undesirable accumulations in the soil. In many localities a full schedule of lead arsenate applications leaves excessive spray residues on fruit at harvesttime.

Literally thousands of materials have been tested as possible replacements for lead arsenate, but few have survived initial tests.

New ways of using nicotine have been devised. Originally employed chiefly as a contact insecticide against soft-bodied sucking insects, nicotine was used in such a form that it volatilized readily, and was washed off quickly by rains. Several compounds of nicotine have now been developed that remain effective on the fruit or foliage over periods of days or weeks. The leading mixture of this type is nicotine bentonite, which has been used effectively in thousands of acres of apple orchards in Indiana, Illinois, and elsewhere.

Phenothiazine, first tested in 1934, is very poisonous to the codling moth, but has given uncertain results. Much of this irregularity was overcome in the drier parts of the Northwest by the use of a very finely divided material. Elsewhere the finely divided material is still not entirely dependable. Unfortunately phenothiazine causes certain susceptible individuals to suffer a serious skin condition similar to severe sunburn. Spray men, pickers, and others who work in sprayed trees may suffer from it. Phenothiazine causes some interference with proper sizing and coloring of fruit; it is also rather expensive. Despite these difficulties, a few growers use phenothiazine, usually mixed with lead arsenate.

Xanthone also has shown promise for control of the codling moth, especially in the Northwest, but the results have been irregular and its acceptance by growers has been limited. Xanthone exhibits one unexpected quality: Its continued use seems to prevent outbreaks of orchard mites and the woolly apple aphid. On this account there is now some interest in the use of xanthone with DDT.

Tartar emetic, formerly used chiefly as a poison in ant baits, came into use for the control of the citrus thrips in California about 1939. Within a few years, however, it seemed to have much less value for the purpose in certain areas. Apparently the susceptible thrips had been killed off, leaving a more resistant race of them to carry on.

The outstanding new material is DDT. From the very first laboratory tests, it has given marked control of the codling moth. In many cases a spray containing one-half pound of DDT, in a water-dispersible powder, per 100 gallons, has given much better control than 3 pounds of lead arsenate. The use of DDT at reduced strengths (4 to 6 ounces per 100 gallons), with about half the usual strength of lead arsenate or nicotine bentonite in all apple sections and with cryolite or xanthone in the Northwest, has also given good control. Besides the usual small-scale experiments, tests have also been carried on in large blocks in com-
commercial plantings, in cooperation with growers, with similar outstanding results.

DDT has also shown promise in limited tests against many other fruit insects, among them the tarnished plant bug, which causes distortion of peach fruit, the oriental fruit moth, the rose chafer, the pear thrips, several species of leafhoppers, and the Japanese beetle and its grubs. Tests against the grape berry moth, the apple maggot, the cherry fruitflies, the peach-tree borer, and some other insects affecting fruit trees have given inconclusive or conflicting results.

DDT seems to have little or no practical value against such important orchard insects as the plum curculio, the San Jose scale, other scale insects, the pear psylla, and several species of orchard mites.

DDT seems to be safe enough for use on fruit trees. Some injury has resulted from the application of mixtures with oil emulsion, but the part played by DDT in this injury has not been entirely clear.

One factor that is important with such a powerful insecticide as DDT is its unfavorable effect on beneficial insects that normally keep many of our insect pests within bounds. Probably the most serious problem of this kind has been the tremendous increase in the populations of mites of various species that has often followed the use of DDT. At ordinary strengths, DDT has little effect on the mites, but it does kill off many of the ladybird beetles and other enemies of the mites. If the use of DDT in orchards becomes general, mite control is certain to become a major problem, even in orchards in which growers have never previously realized that mites were present.

Another problem is that of spray residues. On the basis of studies made thus far, the Food and Drug Administration has announced that no action would be taken on apples or pears containing residues of DDT not in excess of 7 parts per million (about 0.05 grain per pound).

Remarkable as DDT seems, it may prove to be only a stepping stone to even better insecticides. Certain compounds closely related to DDT are being tested; some material in this group may be found that has the effectiveness of DDT without its disadvantages. Many other complex organic compounds are also receiving attention. Prominent among them is benzene hexachloride. Benzene hexachloride has given promising results against the plum curculio and several other insects not affected by DDT, without stimulating increases in mite populations. Unfortunately, benzene hexachloride has an offensive, musty odor that could be imparted to sprayed or dusted fruit.

Several new insecticides are available for spraying when the trees are dormant. Neither lime-sulfur nor the petroleum oils, used during the first 25 years of the century, had much value in the control of aphids, which pass the winter as tiny black eggs on the twigs and smaller
branches. Several materials have recently become available for use against aphid eggs during the dormant period.

For a number of years tar-distillate oils, byproducts from the manufacture of gas, have been used effectively for the control of aphids in the winter egg stage. More recently there have been introduced several materials referred to as dinitro compounds. Two of the more common of these are dinitro-\textit{o}-cyclohexylphenol and dinitro-\textit{o}-cresol. These compounds are effective against the eggs of aphids and may be used with oil sprays for the combined control of aphids, European red mites (in the egg stage), and the San Jose and other scale insects. So, instead of one or two materials for dormant spraying, the grower now has a choice of a half dozen.

The control of the plum curculio in southern peach orchards has been approached from a new angle in the chemical treatment of the ground late in the spring. Two compounds, dichloroethyl ether and dichloroethyl formal, have been successfully used for this purpose on an experimental basis. If the soil treatment is found feasible, it will reduce or eliminate the need for lead arsenate, which causes serious damage to peach foliage and is only partially effective in curculio control.

New materials have been found for the control of the peach-tree borer, to replace paradichlorobenzene, which sometimes injures young peach trees and has other disadvantages. Emulsions of ethylene dichloride have been found effective over a wider range of conditions than paradichlorobenzene, and, when properly used, are less likely to cause injury to the trees. More recently propylene dichloride has been found even more effective in borer control than ethylene dichloride.

Many of the new insecticide materials have been tested over too short a period to permit any evaluation of their probable ultimate place in the orchard insect control program. Despite the increasing complexity of the list of available insecticides and the problems occasioned by their use, rapid progress is being made.

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