A DECADE OF PEST CONTROL IN BRITISH COLUMBIA ORCHARDS[1]

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The last ten years have brought more significant advances in tree-fruit production in British Columbia than any previous period in the history of the fruit industry. Several of the new procedures apply to pest control, and are developments original to this province. Some of them are briefly discussed herein. They were jointly introduced since 1940 by officers of the Fruit Insect Laboratory, Summerland, and the Horticultural Branch, British Columbia Department of Agriculture.

Spray Residue, Soil Poisoning, and the Dual Fruit-wiper

In the late 'thirties, excessive arsenical spray residue had cut off British Columbia apples from the valuable United States market. Unfortunately, heavy lead arsenate spraying was necessary to check the steadily increasing inroads of the codling moth, *Carpocapsa pomonella* (L.). Field experiments in 1939 and 1940 showed that better control of the codling moth could be attained by lessening the periods between the first brood spray applications in May and early June, and by substituting cryolite (sodium aluminium fluoride) or fixed nicotine-petroleum oil for lead arsenate in later treatments (Marshall, 1943). This procedure was recommended and the industry quickly adopted and profited from it. Within a year excessive arsenical spray residue was a thing of the past and the United States market had been regained for over a million boxes of apples a year.

Four years later, Okanagan Valley orchardists led the way in eliminating arsenicals from the spray schedule. In so doing, not only did they remove the possibility of arsenical contamination of fruit but, perhaps more important, they ended the danger of such serious soil poisoning as had occurred in thousands of acres of fine orchard land in the State of Washington.

A survey of packing-houses in 1939 had shown that much of the apple-wiping equipment in the tree-fruit area was inefficient and, doubtless, had been a factor in the loss of the United States market. Shortly before this survey, a new type of fruit and vegetable cleaner had been developed in the United States. It was fitted with revolving brushes and an exhaust fan in addition to the buffer cloths characteristic of the existing wipers. Although nothing was known of its capacity to clean apples, a dual wiper was imported and many chemical analyses were made at the Summerland laboratory to determine its efficiency. The new machine proved superior to the buffer wipers in three respects. It removed more spray residue; it produced a more attractive finish on the fruit; it removed poisonous dusts from the atmosphere. All new wiper installations were recommended to be of this type and packing houses have followed the recommendation with success.

High Viscosity Dormant Spray Oil

The use of dormant petroleum oil was becoming standard practice in western deciduous fruit orchards by 1930. It was generally accepted, and is still accepted in the western United States, that the best type of oil, phytotoxicity and insecticidal effectiveness considered, has a Saybolt viscosity of 100-110 seconds at 100°F. But many orchards in British Columbia suffered bud injury from that type of oil and, in districts heavily infested with the San Jose scale, *Aspidiotus perniciosus* Comst., it lacked effectiveness. Experiments were begun in 1939 to overcome these difficulties. Five years later a new type of dormant oil of 200-220 S.S.U. viscosity was introduced and it is now used throughout this province. There has been less bud injury since the industry abandoned the lighter oil and control of

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the San Jose scale and the European red mite, *Metatetranychus ulmi* (Koch), has been measurably improved (Marshall, 1948).

Dormant Oil-Lime-Sulphur

While the experiments on petroleum fractions were underway, field trials were proceeding with a number of ideas for improving control of the San Jose scale. From that work eventually came a dormant spray mixture that is still the most effective preparation available for killing crusted San Jose scale. It is a mixture of heavy dormant oil and lime-sulphur. In the days of conventional hand application of spray mixtures the oil concentration was two per cent. and the lime-sulphur four. Nowadays the mixture is applied by automatic concentrate applicators at six gallons of oil and twelve of lime-sulphur per acre. There are three advantages in the use of this mixture as compared with oil alone or lime-sulphur alone. First, the presence of the oil renders the lime-sulphur less irritating to the operator. Second, the quantity of oil being only half that required where oil alone is used, the danger of oil injury to buds and twigs is minimized. Third, although synergism has not been established, the mixture seems more toxic than would be expected from the individual effects of the two constituents.

"Low Sulphonation" Summer Spray Oil

Another innovation in orchard pest control in this province is the so-called low sulphonation petroleum oil of about 75 per cent. unsulphonated residue that is used for foliage application. Before the introduction of this oil, only summer oils of about 94 per cent. unsulphonated residue were employed in fruit production. The latter oils cost the growers about twice as much as the "low sulphonation" type but gave no better pest control. The suitability of the cheaper oils was demonstrated in a series of field experiments carried out from 1939 to 1944. No "high sulphonation" summer oil has been used in British Columbia for about five years although it is still the only type of summer oil used in the western United States (Marshall, 1948).

Perhaps one reason that the cheaper oil has been satisfactory in this province is that summer oil has not been used at greater than 0.5 per cent. concentration in hand machines or at more than two gallons per acre in cocentrate machines. At higher concentrations, such as used in many other fruit-growing areas, it is somewhat more prone to cause foliage injury than the expensive oil.

Trunk Spray for Codling Moth Control

For a time in the early 'forties it appeared that the codling moth would soon bankrupt the British Columbia apple grower. In spite of a continually heavier and more expensive spray program the attacks of the insect increased and cullage mounted. In those days DDT was unknown and codling moth control was dependent upon spray applications of lead arsenate, cryolite, and fixed nicotine directed against the first-instar larva, the egg, or both. To supplement this treatment experiments were undertaken to determine whether the codling moth is vulnerable to insecticides when it is a cocooned larva and, later, when it is adult.

Foliage spraying with a dilute solution of dinitro cresol proved moderately effective against the adults but it was not brought to the point of commercial application (Dennys, 1942). Tree-trunk spraying with an emulsion of a petroleum solution (38-40 S.S.U. Vis. 100°F.) of dinitro cresol was developed sufficiently for some growers to use it with fair success against the overwintered cocoons (Heriot, 1942). At that time, however, DDT was under trial and very shortly it proved so effective against the codling moth that supplementary control measures became unnecessary. There have been signs recently that the effectiveness of DDT against the codling moth may may not be quite so outstanding as it was when that remarkable insecticide

was introduced. If that should prove to be so, the day may not be far off when supplementary control measures will once more be necessary. The foliage and the trunk sprays will be available if required, and there is little doubt they can be made more effective.

Monoethanolamine Dinitrocyclohexylphenolate

With the general use of DDT in Okanagan Valley orchards came increased trouble from phytophagous mites (Marshall, 1946). Neither of the acaricides available at that time proved satisfactory for holding the mites in check. One of them, the dicyclohexylamine salt of dinitrocyclohexylphenol, gave erratic results, particularly in cool weather. The other, xanthone, caused alarming dermatitis to susceptible orchard workers.

At the Summerland laboratory work had been conducted for several years on dinitrophenol derivatives as acaricides, and, among other compounds, the monoethanolamine salt of dinitrocyclohexylphenol had been made and its acaricidal value studied. This material proved superior to those recommended at the time (Morgan and Marshall, 1944). Even today it has a particular advantage over several of the acaricides of more recent introduction: apart from being relatively harmless to humans, it appears to have selective action, *i.e.,* it is not harmful to insect predators. A shortcoming of mono DNP, to give it its popular name, is that it may cause foliage injury if used in concentrated form in hot weather. When concentrate sprayers became standard equipment in the British Columbia fruit industry, therefore, the use of mono DNP declined.

The Automatic Concentrate Sprayer

After World War II, labour costs increased rapidly and the fruit grower was faced with a new problem. The value of his product did not advance with his production costs, chief of which was labour. Consequently, labour overhead had to be reduced.

One of the orchard operations that required a great deal of labour was spraying. In 1946, officers of the Summerland laboratory, in co-operation with the Provincial Department of Agriculture and the Defence Research Experimental Station, Suffield, Alberta, undertook to mechanize spraying operations. By 1948 the three services had built and successfully demonstrated an experimental machine. The first commercial units, based on this experimental sprayer, were available in 1949 (Marshall and Miles, 1948, 1949; Marshall, 1949). By 1952, spraying operations had been approximately 90 per cent. mechanized, and British Columbia orchardists were possibly farther advanced in methods of applying chemical control than those of any other fruit-growing area. The automatic concentrate sprayer has saved upwards of 75 percent. of the cost of labour for orchard spraying operations, and perhaps 20 per cent. of the cost of spray chemicals. It has almost eliminated hand spraying, the unpleasantness of which can only be appreciated by those who have spent long hours operating a spray gun.

Introduction of a Parasite of the Apple Mealybug

Seventeen years ago. the fruit growers of the Kootenay Valley noticed an unusual insect in their plantings. It soon became a serious problem because its copious excretion covered the fruit and resulted in the growth of a sooty fungus that rendered the fruit unsaleable until washed. This insect was the apple mealybug, *Phenacoccus aceris* (Sign.), a pest then known to occur only in one other area in Canada, namely, western Nova Scotia. In that area the insect had never been epidemic as it was in the Kootenay Valley; investigation indicated effective control by the parasite *Allotropa utilis* Mues. Subsequently *A. utilis* was reared at the Dominion Parasite Laboratory, Belleville, Ontario, and shipments of it were sent from time to time to the Fruit Insect Laboratory at Vernon. Five years after the first

liberation the parasite was well established in the Kootenay West Arm district and today it gives effective control of the apple mealybug. This must be one of the outstanding exemples, in Canada, of biological control by an introduced parasite (Marshall, 1942, 1944).

Trends in Pest Control Research

Most orchardists in this province are well aware of the importance of biological control of fruit pests. But isolated and abandoned orchards and orchards that have been cultivated but not sprayed show, organic farming enthusiasts to the contrary, that Nature alone will not ensure sufficient marketable fruit for a profitable commercial operation. Consequently, the first line of defence against pests is chemical control—but chemical control applied as sparingly as possible and based on the knowledge that the preferred chemicals are those that have low toxicity to beneficial insects and mites and to birds. In 1948 the investigators in the joint operations of the Canada divisions of Entomology and Chemistry at Summerland were provided with an excellent laboratory and staffs were substantially increased. It then became possible to study insect behaviour in addition to the immediate but practical problems involved in helping to keep the fruit industry on a profitable basis. Biological studies were given welcome support when Biological Control Investigations of the Division of Entomology stationed an investigator at the Summerland laboratory to work directly with Fruit Insect and Insecticide Investigations on the biology of orchard mites. From now on there should be good balance at Summerland between fundamental, long-term biological studies and the entomological-chemical investigations that are a season-to-season necessity.

Summary

During the decade 1940-1950 advances in production methods of the British Columbia fruit industry were greater than in any previous period; some of the most significant were original developments in pest control. These included:

1. Introduction of the dual fruit wiper.
2. Elimination of arsenicals from the spray schedule prior to the introduction of DDT. (This removed the dangers of arsenical poisoning of the soil and arsenical residues on fruits.)
3. Introduction of heavy dormant petroleum oil (200-220 S.S.U. Vis.), which is now the only type of dormant oil used in the province.
4. Development of heavy dormant oil—lime—sulphur mixture as the standard dormant spray mixture for apples and pears.
5. Introduction and general use of summer petroleum spray oil of low unsulphonated residue (under 75%).
6. Development of the tree trunk spray for codling moth control.
7. Introduction of the monoethanolamine salt of dinitrocyclohexylphenol as a selective acaricide.
8. The successful introduction and dissemination of the parasite *Allotropa utilis* for control of the apple mealybug.
9. The designing and construction of the Okanagan experimental sprayer. This machine led to the mechanization of orchard spraying and the general use of spray concentrates in British Columbia.

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NOTES ON THE CABBAGE SEEDPOD WEEVIL, CEUTORHYNCHUS ASSIMILIS (PAYK.) (COLEOPTERA: CURCULIONIDAE), AND ITS PARASITES[1]

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The cabbage seedpod weevil, *Ceutorhynchus assimilis* (Payk.), is an indigenous pest of cruciferous seed crops in Europe. It was first reported in North America by the Division of Entomology (1935, p. 463) from a specimen taken at Vancouver, British Columbia, by Hugh B. Leech in May, 1931. The insect did not become economically important in British Columbia until the importation of turnip, cabbage, and cauliflower seed from Europe was prevented in 1940 by the naval blockade of western Europe. There was then an increase in the acreage planted to cruciferous seed crops on Vancouver Island and the lower mainland of British Columia, and the weevil became the most important insect pest of these crops. The use of parasites to reduce damage by this pest was undertaken in 1943 as a co-operative project between the Field Crop Insect Laboratory at Agassiz, B.C., and the Dominion Parasite Laboratory, Belleville, Ont.

The weevil became economically important in the western United States about the same time as in British Columbia. It was reported in 1935 in the northwestern part of Washington, where most of the cabbage seed produced in the United States is grown (Baker, 1936). From this area it spread southward through Oregon to California, where it was reported in 1946 (Hagen, 1946).

In Washington it became of increasing importance and a laboratory, now known as the Northwestern Washington Experiment Station, was established at Mount Vernon, to investigate the weevil and other pests of cruciferous seed crops. Its biology, distribution, food plants, and parasites were studied (Hanson *et al.*, 1948).

Mr. R. Glendenning, Officer-in-charge, Field Crop Insect Laboratory, Agassiz, studied the course of the infestation in British Columbia from 1939 to 1945. The infestation on the mainland was severe during the early years of his investigation, but gradually became less severe until 1945, when it had virtually disappeared. During this period the infestation on Vancouver Island remained at a high level.

In 1949 a survey was initiated at the Vancouver laboratory to obtain information concerning parasitism of the weevil in British Columbia with special reference to the value of introduced species. Further information concerning its distribution and the degree to which it infests cruciferous seed crops was necessary. The project was continued in 1950 and 1951 and collections of infested material were obtained from the important seed-growing areas from June to October.

The insect was obtained from seed fields of cabbage, cauliflower, Brussels sprouts, and swede turnip and also from wild turnip, *Brassica campestris* L.; garden radish, *Raphanus sativus* L., growing as an escape; and a wild

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