PROBLEMS IN THE COMPILATION OF A SPRAY CALENDAR FOR ORCHARDS IN BRITISH COLUMBIA[1]

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Introduction

Criticisms of the increasing complexity of pest control recommendations for certain types of crops, particularly fruit, are not infrequent. Such recommendations are usually made in the form of a so-called "spray calendar." The writer was successively secretary, vice-chairman and chairman of the committee responsible for the annual drafting of the spray calendar in British Columbia and, of necessity, took a central part in the many discussions as to the function, content, and format of the calendar. During this period the general structure of the calendar was considerably altered and this paper is an effort by the writer to give his views on the present situation.

It is illuminating to look at the British Columbia tree-fruit spray calendars for 1957, 1958 and 1959 (2, 3, 4) and compare them with the calendar for 1936 (6). It is best to go back no farther than twenty years or so, so that we remain in modern times with roughly the same serious insect pests and diseases as we have today, and roughly the same outlook and the same problems of orcharding in general.

In 1936 the tree-fruit spray calendar for British Columbia mentioned 18 pests and six diseases. It listed seven materials (lime-sulphur, oil, bordeaux mixture, nicotine, lead arsenate, strychnine and whitewash). Of the seven, three are deadly poisons. The calendar referred to the same six tree-fruits as it does today—apple, pear, peach, apricot, prune and cherry. In 1957 the same spray calendar (now called "Control of Tree-Fruit Pests and Diseases; With Information on Spray Thinning and Stop-Drop Sprays") covered 39 pests and 14 diseases (not counting virus diseases) and listed 33 pesticides. Although several of these pesticides are mild poisons, only two rank as deadly poisons (nicotine and strychnine; the latter for mice).

In 1936 the calendar was composed of approximately 2200 words, together with some 330 more on small fruits. In 1957 the number of words had increased to over 4000 and the information on small fruits had grown into a separate calendar.

The number of pests and diseases needing attention has approximately doubled in 21 years; but the number of materials has increased fourfold. Words have only doubled but the more leisurely phrasing of 1936 has given place to a brief, perhaps too brief, telegraphic style in 1957 in order to impart the information as concisely as possible. It is worthwhile noting, however, that in the 1957 calendar there are sections on spray-thinning, stop-drop sprays, mineral deficiencies, surfactants, and operation of concentrate sprayers, that were not included 21 years ago.

However, before we get too critical of our own affairs, let us look outside British Columbia. In Washington State the spray calendar (12) is now issued in the form of a 40-page booklet, using nearly four times as much paper as our own. It refers roughly to the same pests but mentions 48 chemicals against our 33. And Ontario issues three calendars to cover only five tree-fruits (9, 10, 11). Nova Scotia (8) and Quebec (7) each issue a single calendar for apples and pears; soft fruits are not grown on an appreciable commercial scale in these provinces (21).

The Background of Orchard Entomology in British Columbia

Recommendations for insect and pest control are influenced by various factors.

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1. In the dry Okanagan Valley, where most of the tree-fruits of British Columbia are grown, insects, rather than diseases, dominate spraying practices.

2. Six fruits are involved and these are often planted in one small orchard, in several varieties. Interplanting is common in British Columbia and, in the interests of time and simplicity, orchardists favour pesticides that can be put usefully on all fruits.

3. Different fruits have different insect faunas. In British Columbia 46 species are listed (17) as of major economic importance on one or more of the six tree-fruits of the province. Of these, 28 occur on apple, 12 on pears, 10 on apricot, 11 on peach, 15 on prune and 12 on cherry. Some species, at a level sufficient to cause damage, occur on several fruits. But many of the most serious pests, and these dominate the spray programmes, occur on one or two tree fruits only, e.g., codling moth *Carpocapsa pomonella* (L.) on apple and pear; peach twig borer *Anarsia lineatella* Zell. on peach; black cherry aphid *Myzus cerasi* (F.) on cherry; pear psylla *Psylla pyricola* Foerst. on pear and mealy plum aphid *Hyalopterus arundinis* (F.) on apricot and prunes.

4. Susceptibility of various fruits, and varieties, to damage by different chemicals varies, often very greatly. For example, Trithion [*O, O*-diethyl *S*-(p-chlorophenylthiomethyl) phosphorodithoate] causes damage to the Golden Delicious and Red Delicious varieties of apple (36); so much so, that in spite of its otherwise excellent qualities as an orchard insectciide, we gave up intentions of recommending it in British Columbia. Fortunately there are suitable alternatives (37) with somewhat similar properties but lower phytotoxicity. A newly introduced pesticide, which proves phytotoxic in our orchard trials to any of our more important fruit varieties, is usually discarded if there are suitable alternative materials available.

5. A major factor in the selling of fruit today is that the fruits should have a very high finish. This is quite distinct from such obvious defects as worminess or gross misshape. The factor is purely an aesthetic one, something that would not arise in a hungry nation; it can be regarded as ridiculous but, nevertheless, it is most important in the sale of fruit. And the economic entomologist, being necessarily concerned with the economics of the industry that supports him, cannot afford to neglect it. The fact, from his professional point of view, is that the surface of fruits makes an excellent display surface for any sort of insect or disease damage, however trivial, and for any sort of blemish caused by spray material. Consequently, he must often concern himself with what are, strictly speaking, minor pests and he must be highly selective in recommending spray chemicals. Consider, for instance, the importance of finish in the sale of apples or peaches today as compared with potatoes, or turnips. Though the requirements for finish are much more exacting, ten acres of apples, or peaches, in British Columbia will, in some years, bring the farmer no more net income than ten acres of potatoes or turnips (21).

6. Recommendations made by the orchard entomologist must fit in with other orchard practices. The orchard entomologist is necessarily closely allied to the horticulturist and to the practices of actual fruit production. His position is quite unlike that of a medical entomologist working on, for example, malaria-carrying mosquitoes; such an entomologist is seriously concerned with only the one or two species of anophelines that are vectors which occur in his area; and there may be little reason for him to be in close contact with the medical man working on drugs for the cure of the disease. For instance: efficient concentrate spraying is only possible if adequate pruning has been done (40); fungicides used by plant pathologists can increase or decrease mite populations (33); the water and nitrogen balance of fruit trees almost certainly (36) affects aphid populations as it does in other plants (19); though lindane [1,2,3,4,5,6,-hexachloro*cyclo*hexane] does not have the

tainting properties of the less pure benzene hexochloride (38) on fresh fruit, nevertheless, its taste can be detected in the processed apple sauce that is produced on a large scale in British Columbia as a means (21) of removing low grade apples from the fresh fruit market; compatibilities of insecticides have to be considered, not only with fungicides, but with blossom-thinning, "stop-drop" and minor-element sprays (35); at certain times spraying cannot be done with a concentrate machine because of the presence of tree-props in the orchard; and late-season application of pesticides is not always possible, not only because of the dangers of exceeding legal residue tolerances (20), but because unsightly, if innocuous, deposits of spray material may depress the grade of the fruit at the packing house (37).

How Comprehensive Should a Spray-Calendar Be?

The slowly increasing pest fauna, the rapidly increasing number of new chemicals, and the development of pesticide tolerance in insects and mites (18), inevitably brings up this question. Should a spray calendar include all available information on pest and disease control procedures? Or should it be restricted to a few of the most important pests and diseases, and most important control measures? A skeleton outline of essential control measures could almost be put on a postcard and some growers would like nothing better. But extension horticulturists want all the current information available; and many growers want some scope for choice in their spray programmes based on their experience of conditions in their own orchards.

The policy up to the present has been to make the British Columbia calendar fairly comprehensive; District Horticulturists have then abstracted, and issued in typewritten form, a brief minimum spray schedule for their own local areas. This, in fact, emphasizes why it would be unwise to restrict the general calendar in content; for what one District Horticulturist would consider the minimum schedule for his own area is not necessarily suitable for another area. For within a distance of 100 miles or so in the Okanagan Valley, there are quite large differences in insect fauna; in rainfall, soil and frost conditions; and in the fruits and varieties predominant (21, 24). For instance, south of Okanagan Falls the presence of San Jose scale, *Aspidiotus perniciosus* Comst., determines, to a large degree, the nature of dormant spray treatment; lime-sulphur plus oil is an essential recommendation there (23). In the Vernon area, on the other hand, San Jose scale is not present, and the addition of oil to the dormant spray may be a needless expense. The appearance of resistance to pesticides in insects and mites has been, in the first place, sporadic and restricted in location. This has been the situation in British Columbia with resistance to organic phosphates in the European red mite, *Panonychus ulmi*, (Koch), the apple rust mite, *Vasates schlechtendali* (Nal.) and possibly other mites (16, 31). The appearance of DDT-resistance in the codling moth, in 1957, was also localized, not merely as to geographical locality, but also in individual orchards in a given area (27). In the most recent British Columbia spray calendar (4), specific mention was given to recommendations for resistant strains.

There have been other reasons for increase in size of the calendar in recent years. The calendar originally referred to the application of chemicals as sprays for pests and disease control, together with information on the few pesticides not applied by this method. In the past six or seven years, however, the entomologists' and pathologists' techniques of spraying have been extended to the thinning of fruit by the application of materials that act by destroying most of the blossom (13). The chemicals used in British Columbia are dinitro-*o*-cresol compounds similar to those that are applied earlier in the season for insect and mite control, but they are used at a lower dosage. There is,

therefore, logical reason for the inclusion of such information on the spray calendar. Mineral salts (zinc, manganese, boron, magnesium) have been conveniently applied as spray solutions (41) and, as these compounds are used to correct physiological diseases, it is legitimate to include them on the spray calendar. Since some of these salts can also be applied by scattering on the ground, this information is also included on the spray calendar for the sake of completeness. However, we may pause to consider where such extensions of the content of the calendar may lead us. Application of such nitrogenous fertilizers as urea may be accomplished by spraying (12), though it is not recommended in British Columbia at present. If it is ever recommended it is reasonable to suggest that such information be put on the spray calendar. However, for completeness again, it might be argued that recommendations concerning conventional soil applications of similar fertilizers should also be included. In a process such as this, the original spray calendar for pests and diseases could grow into a complete outline of recommendations for general orchard practice.

It is fairly obvious that we have enough categories of diverse information on the calendar now, and, if there is any call for further additions, we should consider dealing with all spray applications, other than those for pests and diseases, in a separate publication.

How Many Calendars Are Necessary?

Ontario (9, 10, 11) issues three calendars and these cover five tree-fruits against our six. However, conditions are somewhat different in Ontario. Acreages are larger and some growers grow only one fruit, e.g., peaches. There is, therefore, good argument for the issue of calendars dealing with only one fruit or group of fruits. As already mentioned, Nova Scotia and Quebec, where soft fruits are not grown on an appreciable scale, each issue a single calendar covering apples and pears only.

However, in British Columbia, although many growers grow apples only, very few grow soft fruits only and very few indeed grow one kind of soft fruit only. Moreover, the peach, the most important soft fruit in British Columbia, has far fewer insect and disease enemies than in Ontario. For instance, two serious peach pests, the Oriental fruit moth, *Grapholitha molesta* (Busck) and the plum curculio, *Conotrachelus nenuphar* (Hbst.) are fortunately absent in British Columbia (17), and these two pests alone force Ontario fruit growers to undertake a spraying schedule (11) at least as extensive as that for apples (3) in British Columbia. Provided, therefore, we can reduce extraneous matter on the calendar, it is reasonable to continue with a single official general calendar. From this one calendar, local horticultural advisors will, no doubt, continue to abstract brief typewritten schedules to suit their districts and preferences. But if, as mentioned in the last section, more categories of information are to be covered in the future, then we will have to consider a second medium of publication; but it is suggested that the division should not be on the basis of separate calendars for separate fruits, for this would lead to much unnecessary duplication of information, as far as recommendations in British Columbia are concerned.

General Arrangement And Presentation

Twenty years ago the arrangement and presentation of a spray calendar was no great problem. Procedures could be grasped without much difficulty, whatever arrangement was used, because the number of pesticides available was small and did not change much from year to year. Now with much more information to impart, and with annual changes, the design of the spray calendar is a matter of concern if the grower is not to be disheartened by the mass of instructions offered him.

Arrangement may be made in three basic ways:

1. Listing by Pests and Diseases

This is, more or less, a catalogue of pests and diseases with alternative control measures, pesticide, rate of application and timing, listed for each. Up to 1957 the British Columbia tree-fruit calendar was of this kind (2). It was definitely not in the form of a programme or schedule for seasonal spraying. But local schedules were compiled from it by district advisory horticulturists. It is extremely economical of space, and involves a minimum duplication of information since a pest or disease is referred to only once, on whatever crop it occurs. Control measures are also listed only once in a separate section and referred to by index numbers opposite each pest or disease.

This form of presentation is the obvious one for entomologists or pathologists whose interests are centred around the insects or diseases. Moreover, the almost complete change, in British Columbia to concentrate spraying has made it possible for the orchardist to apply sprays only when it is obviously necessary, so that a pre-arranged programme, except in the case of codling moth, is no longer necessary. In the past, when the spraying of an average ten-acre orchard might take several days, instead of five or six hours as now, such short-notice spraying was often out of the question.

2. Listing by Crops

This is the basic arrangement for the pest and disease-control calendar for vegetable and field crops in British Columbia (5). Here it appears to be a natural method as the number of crops, or categories of crops, is nineteen, and it is difficult to see what other arrangement could have been used. There is also, in this calendar, a section on pests or diseases of a general nature (grasshoppers, etc.).

3. Listing by Date

This is a true calendar with the dates of application being indicated: dormant, pre-pink, post-blossom, etc. It is followed conveniently in some calendars devoted solely to one crop, e.g., apple in Ontario (9). If several crops are involved it is followed with difficulty unless some subdivision, on a crop basis, is also made. This is the form that horticultural advisors seem to prefer as most natural for the grower. However, since it soon becomes obvious that the seasonal calendar must be subdivided on a crop basis, some duplication will occur because of insects and diseases that are common to several crops. This means a larger calendar. In fact, the 1958 calendar for British Columbia tree-fruits was revised (3) on this basis and its area is one and one-half times that of the 1957 calendar. Even so, it was found necessary to include a section on "miscellaneous pests" for those pests that did not fit easily into a seasonal spray schedule (earwigs, cutworms, mice, etc.). Such duplication, limited to the extent that all information can be presented on one chart, is perhaps, not entirely undesirable because it can serve to reiterate important parts of the recommendations to growers.

Introduction of New, and Removal of Old Spray Chemicals

This question has become a major one because of the flood of new materials available. It is a problem that hardly existed before the era of DDT. The following questions arise:

1. How extensive should experimental work be before a new material is recommended to the grower? The entomologist or pathologist normally wants several years of experiment before he is certain of his judgment; for seasonal differences from year to year often profoundly affect insecticidal efficiency, or degree of phytotoxicity. An older generation of orchard entomologists (14), held that a period of not less than five years was necessary to test a pesticide in the field; entomologists of today's tempo have generally shortened this period, but the shortening cannot go too far. An example of this is our recent experience with Trithion (36). This material was so satisfactory, after trials in 1955 and

1956, that we considered recommending it for the 1957 calendar but finally decided against doing so. This was fortunate for the material caused such extensive damage to leaves, and reduced the crop in the 1958 trials, that we have been forced to discard it.

2. If chemicals already recommended are satisfactory, is there any point in emphasizing new materials until they are needed, or unless they have some outstanding new advantage? It is generally felt that the answer to this question is no; however, in practice, very few chemicals already recommended are satisfactory in every respect and usually a case can be made for the inclusion of a well-tested new material.

3. Should cost be a factor in putting a new material on the calendar? New materials are generally relatively expensive; however, the price is usually reduced shortly after the preparation comes into widespread use. The usual practice has been to introduce new materials slowly. Thus, although the effectiveness of diazinon as an orchard insecticide was already apparent to us (37), it was first inserted, in view of its initial high price, on the 1957 spray calendar (2) only for the control of black cherry aphid. This was because there were then objections to almost all other materials used against this pest (37) and the high priced diazinon seemed to have a place in protecting a high-value fruit. A year later (3), with the price substantially reduced, it was recommended for all aphids on tree-fruits and for eye-spotted bud moth, *Spilonota ocellana* (D. & S.). In the most recent calendar (4), diazinon has been recommended against a wide range of pests.

4. Should we introduce a new material, excellent in every respect, but effective against only a few pest insects? Such a policy may lead to an expensive spray schedule in that several materials may be needed in a given application. And, in addition, this policy may lead to the listing of even more materials on the calendar.

5. Should materials be introduced that appear to be incompatible with natural and established biological control? The biological balance between predator (or parasite), and prey, holds insect populations at a fluctuating, but more or less, constant level; however, the level is much influenced by climatic conditions, or by conditions that are themselves influenced by climate (1). It is unfortunate for fruit growers in British Columbia that, under the warm, arid conditions of the interior, the level at which, for instance, codling moth populations persist, is high. Two summer generations and a partial, at least, third generation are usual. With this high biotic potential, control with introduced species of parasites has not been commercially successful in spite of the establishment of the parasites (22). Growers in Nova Scotia are fortunate in that they can rely to a greater extent on natural control and to a lesser extent on chemical control (34); the reverse is the situation in British Columbia (23, 28, 32). Moreover, control with chemicals of moderate toxicity (30) has not been as successful in British Columbia as it has been in Nova Scotia where conditions are such that the codling moth rarely passes through a second generation. The Nova Scotia spray calendar is, in fact, the smallest in Canada for tree-fruits and refers to the fewest chemicals (8). In British Columbia a fully effective material must be used for codling moth whatever the side effects may be. DDT, with its consequent upsurges of mite populations, had to be accepted to save the grower from disaster (22) and Sevin [N - methyl - 1 - napthyl carbamate], which has the same disadvantage, will also have to be accepted now that DDT resistance has appeared in the codling moth in British Columbia (27). On other fruits, however, where DDT has not been so indispensable, we have tried to restrict use of this insecticide; and for the same reason Sevin is, at present, recommended only for apple pests (4).

6. Should highly toxic pesticides be recommended? The use of very poisonous materials such as TEPP [Bisdiethylphosphoric anhydride] is com-

mon on many parts of the world. However, local conditions must determine if official recommendations for such pesticides are to be made. The Okanagan Valley of British Columbia is noteworthy in that practically all the fruit is grown in small, highly-productive, family-operated orchards; although approximately one-half of the total of Canada's annual crop of tree-fruits comes from the Okanagan Valley, this aspect of its production is not generally known. The average orchard is under eight acres and approximately one-fifth of the holdings are less than two and one-half acres (21). There are houses on almost all these orchards. In addition, with the increasing residential population of the Okanagan Valley, many small lots, of a quarter of an acre or so, have been cut out of orchards and sold as homesites. The human population in the rural area is therefore much higher than in many other places where orchards are much larger. The population contains a high percentage of children who inevitably wander into the orchards. The dangers to them, particularly from cover crops contaminated with the more poisonous organic phosphates, can readily be appreciated. Although our attitude in the matter may seem to be unusually rigid, we have therefore adopted, in view of the peculiar British Columbia conditions, a firm policy of not recommending (and therefore doing only limited experimentation on) pesticides highly toxic to man. Our view has been that an adequate selection of reasonably safe materials has been available for the problems of the moment. For this reason we have done little with systemic insecticides until very recently, when suitable systemics of sufficiently low mammalian toxicity, such as Dimethoate [*O, O*-Dimethyl *S*-(*N*-methylcarbamoylmethyl phosphorodithioate] were developed.

7. How should pesticides be recommended to comply with legal tolerance requirements? A new material is not introduced on the spray calendar in British Columbia until a tolerance has been established under the Food and Drugs Act in Canada, and a permanent tolerance established under the Pesticides Chemicals Amendment to the Federal Food, Drug and Cosmetics Act in the U.S.A. The latter requirement is accepted because a considerable portion of fruit from British Columbia is shipped and sold in the U.S.A. and it would not be economical, in packing houses, to keep fruit sorted on the basis of the pesticides it had received during the season. Information that the grower wants, in this respect, is how close to harvest can pesticides be applied without danger of exceeding legal tolerances. Data on this point were included on the most recent calendar issued (4). In estimating these periods, however, other factors besides the purely chemical aspect of residues were considered. According to Mr. K. Williams, Chemistry Laboratory, Summerland, B.C., some materials, such as Sevin, have such a high tolerance that they can be applied the day before harvest, at the recommended rates of application, without fear of exceeding the legal tolerance. However, the wettable-powder formulation leaves an unsightly, though harmless, deposit and removal of such an appreciable deposit would probably add considerably to packing-house costs. Though emulsions do not have this drawback, wettable-powder formulations are preferred in British Columbia (35).

The removal of older materials from the calendar also presents problems. Some chemicals were removed without difficulties. Thus, methoxychlor [1,1,1 - trichloro - 2,2 - bis(*p*-methoxyphenyl ethane], as an alternative to DDT for codling moth, was never very popular with growers and it was removed simply because, since it was more expensive than DDT, very little was being sold. Others, such as cryolite (sodium alumino-fluoride), also once used against codling moth, was rapidly abandoned when something better was available. Since they were no longer used, their removal was no problem. On the other hand, we abruptly removed lindane without reference to the growers, once it became evident that it was being mis-

used and causing tainting of processed fruit. Some materials have been removed very slowly. Thus, the use of dormant oil has gradually declined; mixtures of dinitro compounds and oil are no longer recommended. However, lime-sulphur plus dormant oil still persists because it has been the only consistently effective material against San Jose scale in the southern Okanagan Valley. Nevertheless, the newer organic phosphates and carbamates offer promise against this pest, and it is possible that dormant oil will disappear completely from the calendar before long; unless pesticide-resistance problems increase to the point that we are forced to rely more on dormant oil sprays. Oil is an effective dormant material but is prone to cause plant damage if not used properly; there do not, however, appear to be examples of any insects (18) that have developed resistance to oils.

A few growers use materials (mainly on strength of advertisements in U.S. fruit grower magazines) that have never been recommended in British Columbia. If such materials are registered for use on any plant anywhere in Canada, then there is no legal barrier to their purchase by a fruit grower. Since we have always had good reason for not recommending such materials, nothing is gained by indicating rates of application, etc. for them on the calendar.

How Many Materials for One Pest?

The reason that several materials are listed for control of one pest or disease may simply be that new materials are recommended, while at the same time, older materials are still widely used and only slowly being supplanted. However, there are often other good reasons why several alternatives should be listed. For instance, up to 1957, six materials (2) were listed for the control of the rust mite, *Vasates schlechtendali* (Nal.). That, on occasion, has been a cause of complaint. The argument has been: why not list just the best one or two measures? In the dormant season the recommended materials included dinitrocresol, lime-sulphur alone, and lime-sulphur plus oil. These alternatives were given because of other pests that might be present at the same time. Dinitro-*o*-cresol controls rust mite effectively and is a more pleasant material to handle than lime-sulphur. On the other hand, if the blister mite, *Eriophyes pyri* (Pgst.) is also prevalent, lime-sulphur is the preferred material because it is more effective than the dinitros against this species. And lime-sulphur plus oil is the best spray material if San Jose scale is present; lime-sulphur alone is less effective and the dinitros are of no use against this species (23). Three different types of summer sprays were also listed for the rust mite because evidence of abundance of the mite may not be apparent until the season is well advanced. The recommended materials were Aramite [2-(*p*-*tert*.-Butylphenoxy) - isopropyl 2' - chloroethyl sulphite] which is very effective but causes damage on pears (3, 15); Sulphenone [4-chlorodiphenyl sulphone] which is less effective (15) but can be used on pears; and wettable sulphur which is cheap and effective but is more likely to cause foliar and fruit injury than the other two substances (29).

Problems of Concentrate Spraying

The orchard spray calendar of British Columbia is unique in that it is designed around application of sprays by mobile, air-blast concentrate sprayers. High-volume sprays, whether applied by gun-machines or by automatic equipment, are now little used by orchardists in this province (26). Specification of rate of application was simple with such dilute sprays. Spray mixtures were made up at a given concentration and the material applied until the leaves were dripping; because of this run-off, excess deposition was impossible unless the leaves were allowed to dry and then resprayed. Application by air-blast concentrate sprayers, however, is equally simple provided the machine is correctly designed and ad-

justed and the rules for concentrate spraying are followed. Marshall (26) has defined efficient concentrate spraying as that in which output, rate of travel, and nozzle adjustment, of the moving air-blast machine is such that the whole tree is uniformly sprayed with no drip from any of the leaves or fruits. There is, therefore, a brief note on concentrate application on the spray calendar. There is also considerable mention, with somewhat different detail, on the compatibility chart (35). Perhaps all the information should be in one place.

Rate of application is specified on the total amount of material to be applied per acre. According to Mr. K. Williams, Chemistry Laboratory, Summerland, B.C., extensive data accumulated over several years show that this amounts, in a mature British Columbia orchard, to specifying the amount of DDT deposited on a square inch of leaf or fruit surface, and in practice if the correct procedure is adopted, the deposits do not vary more than would be expected from a suitable mean value. The instruction on the calendar is: "Determine tank output on acreage basis; e.g., if tankful covers 1¾ acres, use 1¾ times the material listed in column of the chart titled 'amount per acre' when filling the tank." The merits of specifying rates of application in this way have been dealt with by Marshall (26). Attempts to specify the strength of materials in the tank of the concentrate sprayer, without reference to the output-per-acre of the machine, lead to most complex instructions (12).

On the other hand, we do retain a column in the "Formulae" section of the spray calendar that indicates dilutions for application by hand-gun methods. This is because a few growers still own the older machines, and also because the use of dilute spray mixtures applied by hand-guns to the pump of the concentrate machine, is the most economical method for very young trees. Young bearing trees are best sprayed with the usual air-blast concentrate at the standard per acre rate, but with the spray shut off between gaps in the trees. This leads to a lower per-acre output than is indicated on the spray calendar but this is such an obvious procedure that it is not mentioned.

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A Note on the Gordon Stace-Smith Beetle Collection

In volume 55 (1958) of our Proceedings, I stated that Mr. Stace-Smith had 2400 species of British Columbia beetles in his collection. He **DID** have, but that was a count he sent me some time ago. As soon as he received his copy of our Proceedings he hastened to tell me that he had well over 2700 species, with at least 50 more on hand which would bring the total number to 2800 species, plus or minus a few, all from this Province.

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