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**WHO EXPERT COMMITTEE ON
INSECTICIDES**

Nineteenth Report

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CONTENTS

	Page
1. Use of pesticide formulations in public health programmes .	5
2. Collaboration with other Organizations	7
3. Establishment of specifications	8
4. Deletions of specifications	15
5. Changes in methods	16
6. Development of specifications for new pesticides	17
7. Recommendations	18

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Geneva, 19-23 April 1971

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CHEMISTRY AND SPECIFICATIONS OF PESTICIDES

Nineteenth Report of the WHO Expert Committee on Insecticides

The WHO Expert Committee on Insecticides met in Geneva from 19 to 23 April 1971 to study the problems related to the chemistry of pesticides used in public health and to the establishment of specifications for a new edition of the WHO manual *Specifications for Pesticides used in Public Health*. Dr L. Bernard, Assistant Director-General, opened the meeting.

1. USE OF PESTICIDE FORMULATIONS IN PUBLIC HEALTH PROGRAMMES

The world-wide use of pesticides is increasing, both in amount and in diversity. The Committee noted that, although the bulk of the pesticides produced are used in agriculture, all vectors of public health importance are at present controlled by chemicals and no efficient or economically acceptable alternative control methods are likely to become available in the foreseeable future.

To avoid undue contamination of the environment it is necessary to envisage progressive replacement of highly persistent organochlorine insecticides, such as DDT and dieldrin, by less stable compounds. The most promising substitutes belong generally to the organophosphate and carbamate groups; synthetic pyrethroids are also being developed and show considerable promise.

The slow but continuous increase in the number of vectors resistant to insecticides and in their distribution necessitates the development of new compounds belonging to widely different chemical groups. The appearance of rodent populations resistant to chemicals is also causing much concern. As new pesticides are introduced to meet these situations the need arises to develop specifications for them, and the Committee noted that world resources for testing such specifications are rather limited.

In view of the general concern about environmental contamination, the Committee noted with satisfaction that a knowledge of vector ecology is permitting the better use of compounds and formulations specifically developed to control the target organisms. This selective type of applica-

tion materially decreases the hazards of environmental contamination. The Committee recommended that research on such formulations be strengthened.

The Committee realized that an increased biological performance alone was not sufficient reason for introducing a new compound. The new material must also be commercially available and competitive in price and present minimum toxic hazards to man and domestic animals. The Committee noted the increasing use of several new insecticides, such as propoxur, fenitrothion, Abate and Dursban. In this context it is interesting to note the possible replacement of DDT by methoxychlor in certain situations because it is more susceptible to biodegradation; thus, methoxychlor is once more included in the group of compounds recommended for public health use. Similarly, zinc phosphide is again being increasingly used to control rodents because of the development of resistance towards the anti-coagulant rodenticides. It was therefore recommended that specifications be prepared for both methoxychlor and zinc phosphide. Although there has been little change in the methods of application of pesticides used in routine programmes for the eradication or control of vector-borne and rodent-borne diseases, the Committee noted with great interest that the ultra-low-volume (ULV) application of technical or high-concentration formulations of insecticides appears to be a promising technique for curtailing certain mosquito-borne epidemics. Such a method is of special interest for controlling yellow fever, dengue haemorrhagic fever, and encephalitis outbreaks, and may also prove useful in malaria epidemics in some circumstances.

Vector-borne and rodent-borne diseases occur all over the world but are of particular socioeconomic importance in tropical areas and in developing countries. In many of these areas problems of transport and storage are encountered and laboratory facilities and financial resources are restricted. This makes it necessary that pesticide formulations should have a high content of active ingredient and be stable when stored for long periods in tropical conditions. Furthermore, analytical methods must be available that do not require rare and costly pieces of equipment and reagents. These specific requirements were taken into account while reviewing the specifications.

The problem of pesticide specifications is of great importance for at least three international agencies: FAO and WHO, as government advisers, and UNICEF, as the largest pesticide buyer, either directly or when acting on the behalf of individual governments. Several other groups, such as the Collaborative International Pesticide Analytical Council (CIPAC) and the Groupement international des Associations nationales de Fabricants de Pesticides (GIFAP) are also involved in the development of specifications and methods of analysis for pesticides. The Committee noted with satisfaction that WHO is in close co-operation with these agencies and organiza-

tions with a view to making the most effective use of the limited resources available. The Committee hoped that such co-operation would be continued and expanded.

Pesticides are used in public health programmes under a great variety of conditions, such as for house spraying and dusting, river and irrigation systems, gallery forest spraying, human body dusting and indoor and outdoor space spraying. Some are also used as poison baits. The Committee was acutely aware of the implications of such applications for the environment and noted that even greater problems resulted from the agricultural use of pesticides. The Committee recommended that the fate of the pesticides should be more completely investigated, paying special attention to the amount of pesticides applied, the longevity of the parent compounds, and the chemical nature and persistence of the degradation products and their hazards. The understanding and solution of these problems will require the increased participation of chemists and their closer co-operation with the biologists.

2. COLLABORATION WITH OTHER ORGANIZATIONS

2.1 UNICEF

The Committee was informed that the specifications published by WHO are used by UNICEF for the procurement of pesticides for various national programmes. UNICEF has been a major purchaser of DDT powder and is now undertaking to procure newer materials, such as malathion powder, on a reimbursable basis for malaria programmes.

The Committee noted with satisfaction that WHO is providing technical guidance to UNICEF in the use of the specifications and urged that this collaboration should continue. It recommended that WHO should obtain and analyse samples of pesticides that have been procured and shipped by UNICEF as this would provide useful information on which to base improvements in the specifications.

2.2 FAO

FAO has appointed a working party for the development of specifications for pesticides used in agriculture. Some of these materials are also of interest for use in public health.

The Committee recommended that the WHO continue to collaborate with FAO in order to obtain as much conformity as possible between the specifications in which WHO and FAO have a common interest, and between the methods of analysis prescribed in the specifications.

2.3 CIPAC

The Collaborative International Pesticides Analytical Council (CIPAC) is a group of official chemists that has undertaken to standardize the chemical and physico-chemical methods of analysis of pesticides and to carry out collaborative studies. In this work close collaboration with other similar committees, such as the Association of Official Analytical Chemists (AOAC) and the Groupement international des Associations nationales de Fabricants de Pesticides (GIFAP) has allowed the same methods to be adopted by other organizations, and through collaboration with FAO they have also been adopted for use in the FAO specifications. Furthermore, there has been close collaboration with WHO and several methods have been recommended for inclusion in the specifications approved by this Committee.

The Committee recommended that the collaboration of WHO with CIPAC be further developed and that as many methods as are needed be included in the WHO specifications. The Committee noted that new and confirmed analytical methods are required for the public health pesticides propoxur, dimethoate, Abate, Dursban, and urged that CIPAC give these high priority.

CIPAC has published a *Handbook* giving methods and other related techniques and in the following sections references to these are made at the appropriate places.

2.4 GIFAP

The Groupement International des Associations nationales de Fabricants de Pesticides (GIFAP), representing pesticide manufactures, has a technical committee that collaborates with FAO and CIPAC on the development of specifications and analytical methods and on related matters such as toxicology.

The Committee noted with satisfaction that similar collaboration has recently begun between GIFAP and WHO and recommended that this collaboration be continued in order that WHO may obtain complete and accurate technical information on pesticides and their formulations.

3. ESTABLISHMENT OF SPECIFICATIONS

The Committee reviewed the specifications contained in the third edition of *Specifications for Pesticides used in Public Health* and the interim specifications for new pesticides that had been prepared since this subject was last considered by a meeting of the WHO Expert Committee on Insecticides.¹

¹ Fifteenth Report of WHO Expert Committee on Insecticides, WHO/Vector Control/66.199.

In many cases the existing specifications were found to be satisfactory and no changes were recommended. Comments on other specifications and recommendations for their revision and for new specifications are given in the following sections.

3.1 Comments on specifications in which no changes were recommended

3.1.1 *Lindane (Specification WHO/SIT/3.R3)*. The Committee appreciated the continuing need for the specification for lindane and considered that since no difficulties had been reported the present specification should be retained.

3.1.2 *Pyrethrum (Specification WHO/SIT/7.R1)*. The Committee considered alternatives to the technique employed in the current specification and noted that this method was also used by both AOAC¹ and CIPAC.² It recommended that the method should be retained as other methods, e.g., GLC and ethylene diamine titration, were not sufficiently advanced.

3.1.3 *Technical Trichlorfon (Tentative Specification WHO/SIT/13.R1) and Trichlorfon Emulsion Concentrates (Tentative Specification WHO/SIF/20.R1)*. As trichlorfon has not been used extensively, the Committee recommended that these specifications should remain tentative.

3.1.4 *Technical Dichlorvos (Tentative Specification WHO/SIT/16)*. The Committee noted that the specification was for the technical product only and, in the absence of further data on the use of the analytical method, recommended that the specification should remain tentative.

3.1.5 *Technical Coumachlor (Specification WHO/SRT/3.R1), Coumachlor Concentrates (Specification WHO/SRF/1.R1), Technical Warfarin (Specification WHO/SRT/6.R1), Warfarin Concentrates (Specification WHO/SRF/2.R1), Technical Pindone (Tentative Specification WHO/SRT/9.R1), and Pindone Concentrates (Tentative Specification WHO/SRF/4)*. The Committee reviewed these specifications and, in the absence of further data on the analytical methods, recommended that no changes be made.

3.1.6 *Technical Pentachlorophenol (Specification WHO/SMT/2.R1)*. The Committee considered the current specification in the light of information on the method under consideration by CIPAC, which distinguishes the contaminant tetrachlorophenol. In the absence of information on the effect of this impurity on performance of the compound as a molluscicide,

¹ *Official methods of analysis of the AOAC*, 11th ed., 1970, pp. 88-89.

² *CIPAC Handbook*, vol. I, London, Collaborative International Pesticides Analytical Council Ltd., 1970, pp. 598-606.

the Committee recommended that the present method be retained until sufficient data are available upon which to base a decision on this specification.

3.2 Specifications in which changes were recommended

3.2.1 *Technical DDT (Specification WHO/SIT/1.R3)*. The Committee reviewed the specification for technical DDT and discussed a proposal to establish the minimum requirement for the setting point of technical DDT at 92°C. It was recognized that the higher the setting point of the technical product the better are the storage qualities of the finished 75% water-dispersible powder. It was noted that FAO maintains 89°C as the minimum requirement for the setting point of technical DDT. The Committee decided to retain the requirement of 89°C given in the present specification, with the addition of a footnote advising the purchaser that for formulating 75% water-dispersible powder the use of a technical DDT with a higher setting point may be necessary to obtain a finished product of satisfactory quality, depending on the equipment used and the prevailing climatic conditions.

The Committee noted that in the method for determination of the setting point in the specification no stem-correction was described and recommended that it be included in the new edition.

3.2.2 *DDT Water-Dispersible Powders for Overseas Shipment (Specification WHO/SIF/26)*. The Committee was informed that some problems had arisen as a result of foaming. It was decided not to include a specific requirement on foaming in the specification but to change the description of the material in section 1.1 so as to avoid undue foaming under normal use conditions.

The Committee discussed the suspensibility test procedure and noted that some problems had been experienced in the determination of DDT in the 25-ml aliquot from the suspension. It was agreed that no changes in the procedure could be recommended at this time but that further research on the method is desirable.

3.2.3 *Technical and Refined HCH (Specification WHO/SIT/2.R3), HCH Water-Dispersible Powders (Specification WHO/SIF/2.R3), HCH Emulsion Concentrates (Specification WHO/SIF/5.R3), and HCH Dusting-Powders (Specification WHO/SIF/17.R2)*. The Committee noted that some difficulties had been experienced in the separation of the gamma isomer in the analysis of technical HCH and HCH formulations. The difficulties encountered appear to be due to the inability to obtain uniform silica gel for adsorption chromatography, which is the basis of this procedure. The Committee noted that good results had been obtained in

collaborative trials¹ in which partition chromatography with nitromethane on silica gel was employed and that this method had been adopted by CIPAC.² The Committee therefore recommended the adoption of the CIPAC method for separation of the gamma isomer.

The method for determination of the gamma isomer of HCH after chromatographic separation was discussed. If the melting point of the crystals is 112°C or above, they may be assumed to be pure enough for gravimetric determination. If not, the determination may be made by IR spectrophotometry or polarography. In view of the simplicity of the polarographic method³ and the availability of the equipment needed, the Committee recommended that this method be adopted.

3.2.4 *Technical Diazinon (Specification WHO/SIT/9.R2)*. The Committee was informed that technical diazinon can now be manufactured in a more highly purified form than that required in the specification ; however it was considered that there is no reason at present to raise the minimum content of pure compound required in the specification.

It was noted that a stabilizer is sometimes added to the technical product by the manufacturer. In order to allow for this practice, the Committee recommended that the words " or added modifying agents " at the end of section 1.1 should be deleted.

It was also agreed that the maximum water content of the technical product should be 0.1% by weight.

3.2.5 *Technical Malathion (Specification WHO/SIT/10.R2)*, *Malathion Water-Dispersible Powders (Specification WHO/SIF/10.R2)*, *Malathion Emulsion Concentrates (Specification WHO/SIF/14.R2)*, and *Malathion Dusting-Powders (Tentative Specification WHO/SIF/22.R1)*. The Committee reviewed the problems associated with the present method for determination of malathion. The method has received much criticism because it frequently yields high results. This is especially true with samples that contain high percentages of impurities. A new method, based on the development of colour in a non-aqueous system, was reviewed and the results that have been obtained with this method were compared with those obtained by gas-liquid chromatography. The use of the potassium salt of *O,O*-dimethyl phosphorodithioic acid as a primary standard was also discussed. The Committee recommended that

(1) the potassium salt of *O,O*-dimethyl phosphorodithioic acid be adopted as the primary standard for the colorimetric method of analysis

¹ Hornstein, I. (1954) *J. Ass. off. agric. Chem.*, **37**, 623 ; *ibid.* (1955), **38**, 290 ; *ibid.* (1956), **39**, 373.

² *CIPAC Handbook*, vol. I, London, Collaborative International Pesticides Analytical Council Ltd., 1970, pp. 32-36.

³ *CIPAC Handbook*, vol. I, London, Collaborative International Pesticides Analytical Council Ltd., 1970, pp. 37-42.

and the procedure for preparation of this salt¹ be described in the methods section of the manual;

(2) the non-aqueous copper colorimetric method² be adopted as a tentative method for the determination of malathion in the specifications for technical malathion and malathion formulations; and

(3) that the calibration curve technique be introduced into the procedure in place of the direct comparison technique.

3.2.6 *Technical 2',5-Dichloro-4'-Nitrosalicylanilide Ethanolamine Salt (Tentative Specification WHO/SMT/4) and 2',5-Dichloro-4'-nitrosalicylanilide Ethanolamine Salt (Tentative Specification WHO/SMF/1)*. The Committee was informed that there have been improvements in the analytical method for 2',5-dichloro-4'-nitrosalicylanilide and that provision has now been made for determination of the contaminant 2-chloro-4-nitroaniline. The Committee recommended that this revised method³ be included in the specifications for technical and water-dispersible powder formulations but that no recommendation on the limits of 2-chloro-4-nitroaniline be made.

A proposal to include a specification for an emulsion concentrate formulation of this material was reviewed and approved (see section 3.3.4).

3.2.7 *Technical Methoxychlor (Specification WHO/SIT/4.R2) and Methoxychlor Emulsion Concentrates (Specification WHO/SIF/11.R1)*. The Committee was informed of the growing use of methoxychlor as a substitute for DDT for certain applications and noted that specifications for methoxychlor were not included in the third edition of *Specifications for pesticides*.

The Committee recommended that specifications for technical methoxychlor and methoxychlor emulsion concentrates, as given in the second edition,⁴ be included in the new edition and that the requirements and test methodology for the emulsion concentrates conform to those for other emulsion concentrate specifications, as recommended by the Fifteenth WHO Expert Committee on Insecticides.⁵

The Committee did not suggest any changes in the analytical method for methoxychlor in the specifications as given in the second edition, but recommended that further work be carried out to bring this method more into line with the analytical method for DDT.

¹ Unpublished working document, VBC/EC19/71.14.

² Unpublished working document, VBC/EC19/71.15.

³ Unpublished working document, VBC/EC19/71.18.

⁴ *Specifications for pesticides*, 2nd ed., Geneva, World Health Organization, 1961 (WHO/SIT/4.R2 and WHO/SIF/11.R1).

⁵ Fifteenth report of the WHO Expert Committee on Insecticides, WHO/Vector Control/66.199.

3.2.8 *Technical Dieldrin (Specification WHO/SIT/6.R3), Dieldrin Water-Dispersible Powders (Specification WHO/SIF/3.R3), and Dieldrin Emulsion Concentrates (Specification WHO/SIF/6.R3)*. The Committee noted that a comparative study had been made of the one-band and three-band infrared spectrophotometric analytical techniques. It concluded, however, that because it was necessary to analyse formulations of widely varying content and sometimes of uncertain origin the three-band method at present in use should be retained. At the same time, the Committee noted that CIPAC intended to retain both methods, the three-band technique being recommended for samples that were either impure or of unknown origin and the one-band technique for routine analyses. In the specification for dieldrin emulsion concentrates, the Committee recommended that the extraction procedure be modified, using silica gel instead of activated charcoal in the chromatographic column.

3.2.9 *Technical Zinc Phosphide (Specification WHO/SRT/7)*

A specification for technical zinc phosphide was included in the second edition of *Specifications for pesticides* but omitted from the third edition. The Committee was informed that there is an increasing need for a specification for this acute rodenticide because resistance has been developing to the anticoagulant rodenticides. The previous specification was reviewed and it was recommended that it be included in the new edition.

The Committee also recommended that the CIPAC method for determination of zinc phosphide¹ be included in the specification in place of the old method.

3.3 New specifications

3.3.1 *Propoxur*

The Committee reviewed the interim specifications for technical propoxur and for water-dispersible powder and emulsion concentrate formulations of propoxur that had been developed in co-operation with the manufacturer and had so far been used mainly for procuring water-dispersible powders for use in field trials. The Committee reviewed the large amount of analytical data on the water-dispersible powder obtained during these trials and recommended the establishment of new tentative specifications for technical propoxur and propoxur water-dispersible powders based on the interim specifications.²

The Committee recommended that the temperature for the accelerated storage test in the specification for water-dispersible powders be main-

¹ *CIPAC Handbook*, vol. I, London, Collaborative International Pesticides Analytical Council Ltd., 1970, pp. 703-705.

² Interim specifications: WHO/IS/1.0033-4 and WHO/IS/2.0033-4.

tained at 34°C but that this be reconsidered when more information is available.

Work on propoxur emulsion concentrates was not considered to be sufficiently advanced for a specification to be approved.

3.3.2 Fenitrothion

The Committee reviewed the interim specifications for technical fenitrothion and the water-dispersible powder and emulsion concentrate formulations of fenitrothion that had been prepared as a result of extensive testing and procurement of this material for field trials. The Committee recommended the establishment of tentative specifications for technical fenitrothion and fenitrothion water-dispersible powder based on the interim specifications¹ but with some changes in the analytical method as given below.

The development of analytical methods for fenitrothion was reviewed. The Committee noted that although some work had been carried out by CIPAC no method had yet been approved; consequently WHO had carried out a collaborative study of a titrimetric method similar to that now in the specifications for parathion and parathion-methyl. The difficulties encountered in the trial by the collaborative analytical laboratories were considered and the Committee approved the analytical method with the following modifications:

- (1) the sulfanilic acid should be dried before use as a standard,
- (2) the sample size should be about 0.75 g equivalent of fenitrothion,
- (3) for the reduction, the amount of zinc should be 3 g and the amount of acetic acid/hydrochloric acid mixture should be 35 ml,
- (4) the diazotization procedure should be carried out at room temperature, with the proviso that the results of the collaborative studies made by the Association of Official Agricultural Chemists should be consulted and a suitable maximum temperature indicated for the guidance of laboratories in tropical areas,
- (5) the end-point should be determined either potentiometrically or by the use of starch-iodide paper.

In addition the Committee recommended that the specific gravity of technical fenitrothion be determined and included in the specification. This information will be of value when the product is purchased for ULV application.

Work on fenitrothion emulsion concentrates was not considered to be sufficiently advanced for a specification to be approved.

¹ Interim specifications: WHO/IS/1.0043-3 and WHO/IS/2.0043-3.

3.3.3 *Abate*

The interim specifications for technical Abate and Abate emulsion concentrates and an analytical method were reviewed. The method is based on ultraviolet spectrophotometric analysis and uses standard Abate for calibration. The Committee recommended the establishment of tentative specifications for both these materials based on the interim specifications¹ and including the analytical method.²

3.3.4 *2',5-Dichloro-4'-nitrosalicylanilide ethanolamine salt*

A proposed specification³ for 2',5-dichloro-4'-nitrosalicylanilide ethanolamine salt emulsion concentrates reviewed together with the proposed change in the analytical method for the technical material and the water-dispersible powder formulation (see section 3.2.6). The Committee was informed that this formulation was of use in molluscicide programmes and therefore recommended the establishment of a tentative specification for this emulsion concentrate formulation.

4. DELETIONS OF SPECIFICATIONS

4.1 **Technical Parathion (Specification WHO/SIT/11.R2) and Parathion Emulsion Concentrates (Specification WHO/SIF/15.R2)**

The Committee was informed that the use of parathion for public health purposes has greatly decreased and is expected to decrease further as a result of its replacement by less toxic chemicals. The Committee recommended that the specifications for technical parathion and parathion emulsion concentrates be deleted from the new edition of *Specifications for pesticides*.

4.2 **Technical Parathion-Methyl (Tentative Specification WHO/SIT/14) and Parathion-Methyl Emulsion Concentrates (Tentative Specification WHO/SIF/27)**

The Committee was informed that the use of this material is also decreasing and recommended that the specifications for technical parathion-methyl and parathion-methyl emulsion concentrates be deleted from the new edition of *Specifications for pesticides*.

¹ Interim specifications: WHO/IS/1.0786-1 and WHO/IS/3.0786-1.

² Unpublished working document, VBC/EC19/71.7.

³ Unpublished working document, VBC/EC19/71.18.

4.3 Flashpoint requirements in specifications for emulsion concentrates

The Committee noted that:

(1) In the FAO specifications no flashpoint requirement is given, but it is stated that the product should comply with national or international transport regulations.

(2) The WHO methods for determination of flashpoint are not consistent with the flashpoints required.

(3) The flashpoint has no bearing on the performance of emulsion concentrates when they are used under normal circumstances.

The Committee therefore recommended that the flashpoint requirements be deleted from all specifications for emulsion concentrates and that a note be inserted in the appropriate introductory sections of the specifications to the effect that the flashpoint of the product should comply with national and/or international transport regulations.

5. CHANGES IN METHODS

5.1 Visual suspensibility test for 75% DDT water-dispersible powders (Method WHO/M/2)

The Committee discussed the visual suspensibility test and recommended that no changes be made but that a warning be given in a footnote to prevent misuse of this test, as it had been developed only for 75% DDT water-dispersible powder.

5.2 Infrared spectrophotometric method for determination of the gamma isomer content of HCH (Method WHO/M/6)

As explained above in section 3.2.3, the Committee recommended replacement of the infrared method by the polarographic method for the determination of the gamma isomer of HCH.¹

5.3 Methods for determination of flashpoint (Method WHO/M/10 and Method WHO/M/11)

As stated in section 4.3, the Committee recommended that the requirements for flashpoints in the specifications for emulsion concentrates be deleted. Consequently, the Committee considered that the methods of

¹ *CIPAC Handbook*, vol. I, London, Collaborative International Pesticides Analytical Council Ltd., 1970, pp. 37-42.

flashpoint determination are not necessary and recommended that these two methods be deleted from the new edition of *Specifications for pesticides*.

6. DEVELOPMENT OF SPECIFICATIONS FOR NEW PESTICIDES

The Committee noted that its work had been facilitated by the availability of interim specifications and recommended that WHO should continue to develop such interim specifications in collaboration with members of the WHO Advisory Panel on Insecticides. This should make it possible to adopt a systematic approach to obtaining collaborative analytical results.

6.1 Specific compounds

Although the interim specifications for propoxur emulsion concentrates and fenitrothion emulsion concentrates were not approved, the Committee recommended that analytical procedures should continue to be developed and collaborative studies performed.

Information presented to the Committee demonstrated that a need existed for specifications for the following pesticides: Abate granules, Paris-green granules, methoxychlor floating oils (for aerial application as a *Simulium* larvicide), technical Dursban, and Dursban emulsion concentrates. The Committee therefore recommended that interim specifications should be prepared for these pesticides and collaborative studies made.

6.2 General

The Committee noted that specifications for granule formulations, providing a guide to the preparation of this type of material, would be of much value and urged WHO to continue to carry out research on the development of such formulations and their specifications. In this connexion the Committee recalled that granule formulations could be of the slow-release type and considered that this aspect should be kept in mind when carrying out research on these formulations.

It is to be expected that the ULV application of insecticides will increase. The Committee therefore recommended that information be obtained on the physical and chemical properties required for pesticides used in ULV application for public health purposes. These data should then be used to develop interim specifications.

7. RECOMMENDATIONS

7.1 Specific Research Items

7.1.1 *Test procedures*

The Committee noted several studies on the development of test procedures that would be of value and recommended that WHO undertake collaborative research where possible. Items that may be considered are :

- (1) Research on the emulsion stability test, in collaboration with GIFAP, CIPAC, and FAO, to ensure uniformity ;
- (2) Comparison of the setting point technique for technical DDT with the CIPAC technique to define a uniform method and terminology (some collaborative work may be necessary) and
- (3) Development of visual suspensibility tests for application to materials other than 75% DDT water-dispersible powder.

7.1.2 *Pyrethroids*

It is likely that new synthetic pyrethroids will be used in applications such as aerosols. The Committee considered that research on analytical methods for these newer materials was important and recommended that support be given to the development of specifications for this group of compounds.

7.1.3 *Storage stability of powders*

The stability of water-dispersible powders shipped to the field and stored for various lengths of time under severe climatic conditions may possibly cause difficulties in some programmes. The Committee recommended that information be obtained on the condition of water-dispersible powder formulations of the newer pesticides, such as malathion and propoxur, after they have been received in the field, in order to assess the influence of factors such as packing density, packaging, and ambient temperatures on the chemical and physical properties and field performance.

7.1.4 *Nozzle tip erosion*

The Committee was informed that nozzle tip erosion is a problem when using water-dispersible powders and urged that research be undertaken on ways of alleviating this problem.

7.1.5 *Particle size measurement*

The Committee discussed the importance of the particle size of water-dispersible powders in relation to the biological effectiveness of residual deposits of insecticides and recommended that studies be undertaken to determine the particle size distribution in formulations commonly in use.

7.2 **Research on long-term general aspects of the chemistry and formulation of pesticides**

7.2.1 *Accelerated storage*

The Committee noted the continuing problem of relating the performance of water-dispersible powder formulations after storage under tropical conditions to the results of accelerated storage tests carried out in the laboratory. Although great improvements have been made in these laboratory tests, the Committee recommended that further work be carried out to establish more exact correlations.

7.2.2 *Pesticides in the environment*

In recent years, widespread concern has been expressed about the effect of pesticide applications on the environment, whether arising from vector control measures or from agricultural or veterinary use. Some study of the fate of pesticides on mud surfaces, walls, etc., has of necessity already been made in evaluating pesticide performance. The Committee recommended that research on the pesticides applied in public health programmes be extended and that a vigorous research programme be started to study :

- (a) the amounts of pesticides present in various parts of the environment and resulting from vector control programmes ;
- (b) the longevity and fate of these pesticide residues and, in particular, a study of the relative rates of loss of different pesticides in various environments ; and
- (c) the chemical nature and hazards to man and animals of the products arising from both chemical and biological degradation of these pesticides.

7.2.3 *Application techniques*

The Committee recommended that further work should be carried out on new techniques and formulations for applying insecticides in a more specific manner than conventional spraying. In conducting this research full advantage should be taken of the available knowledge on vector ecology and behaviour ; this may require further ecological investigations to detect the periods and situations most favourable for the pesticide application.

7.2.4 *Slow release formulations*

The Committee considered slow-release formulations and recommended that additional research be carried out on this type of formulation in specific instances when opportunity arises.

7.3 *Third edition of Specifications for pesticides*

The Committee recommended that the next edition of *Specifications for pesticides used in public health* should include all the methods required for the tests described in the specifications.

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