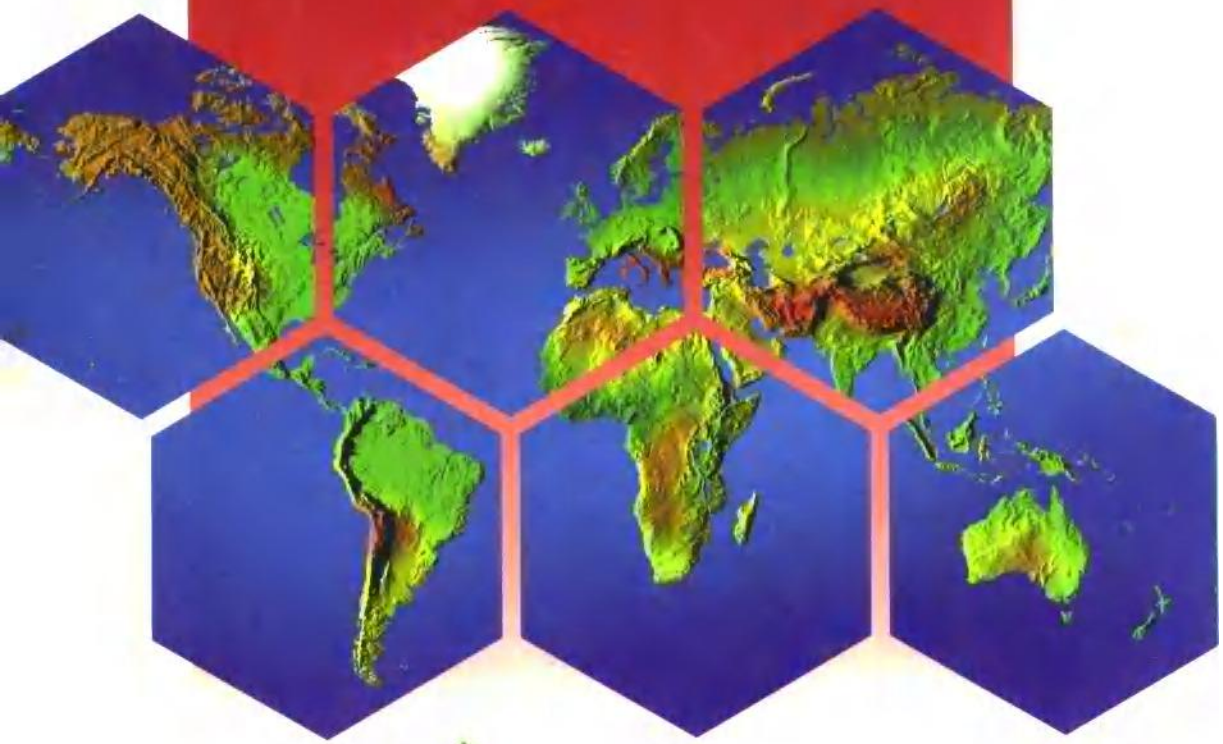
A WORLD COMPENDIUM

The Pesticide Manual

Eleventh Edition

Editor: C D S Tomlin



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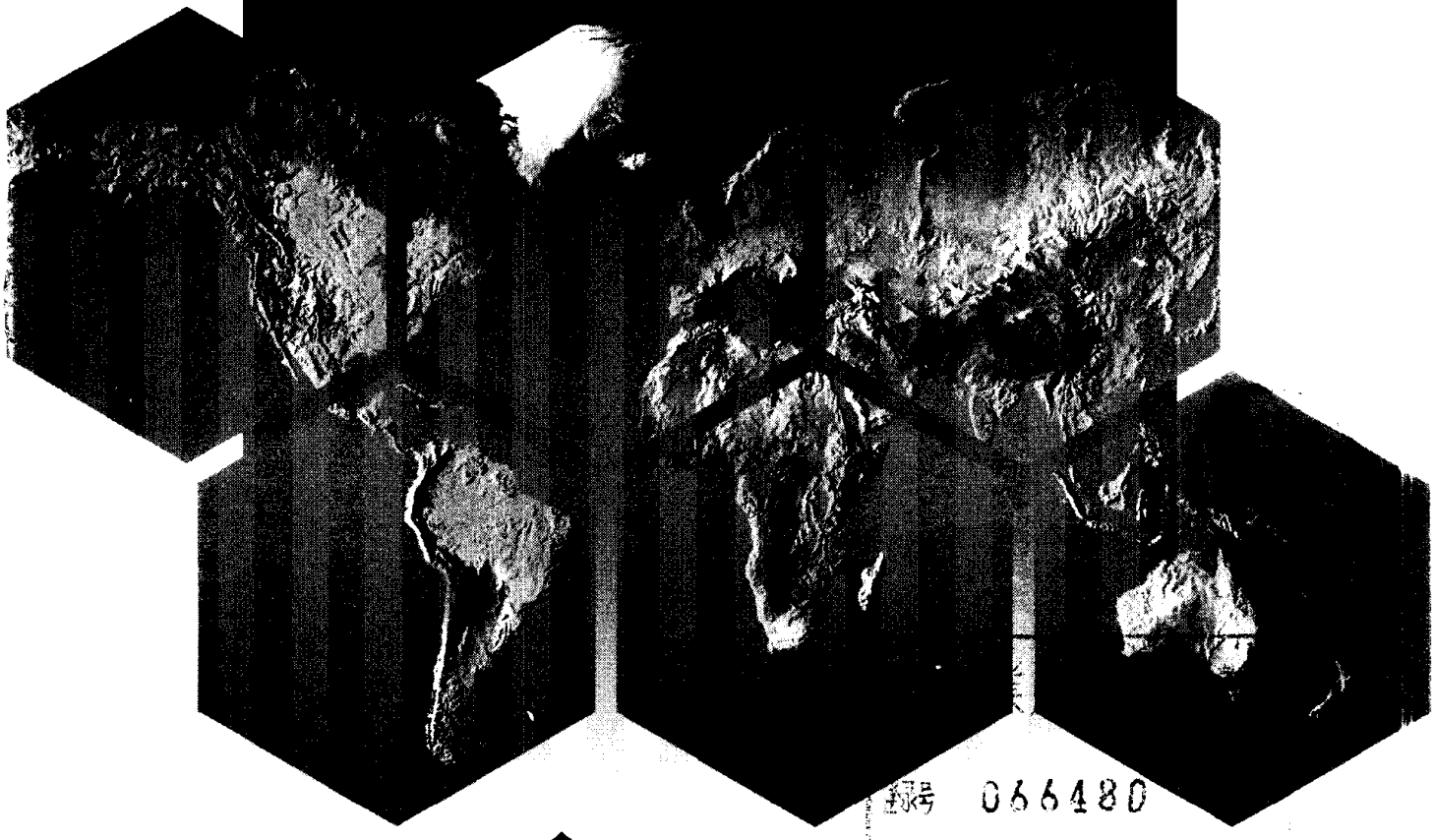

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British Library Cataloguing in Publication Data.
A catalogue record of this book is available from the British Library.

ISBN 1 901396 11 8

First published	1968	Seventh edition	1983
Second edition	1971	Eighth edition	1987
Third edition	1972	Ninth edition	1991
Fourth edition	1974	Tenth edition*	1994
Fifth edition	1977	Eleventh edition	1997
Sixth edition	1979		

* The tenth edition incorporated *The Agrochemicals Handbook* previously published by The Royal Society of Chemistry.

Cover design by Major Design & Production, Nottingham
Typographic design by Alan Brannan Design, Stowmarket
Typeset and printed by Page Bros, Norwich

Published by:
British Crop Protection Council, 49 Downing Street, Farnham, Surrey GU9 7PH, UK
Tel: +44 (0)1252 733072 Fax: +44 (0)1252 727194
Email: md@BCPC.org Internet: http://www.BCPC.org

All BCPC publications can be brought from:
BCPC Publications Sales, Bear Farm, Binfield, Bracknell, Berks RG42 5QE, UK
Tel: +44 (0)118 934 2727 Fax: +44 (0)118 934 1998
Email: publications@BCPC.org

Disclaimer
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Before handling, storing or using any approved crop protection product, it is essential to follow the instructions on the label.

FOREWORD

For nearly 30 years, *The Pesticide Manual* has served as a standard reference work on the active ingredients in products for the control of crop pests and diseases, weeds, animal ectoparasites and pests in public health. During that time it has gradually expanded its coverage to include plant growth regulators, repellents, synergists, herbicide safeners, and latterly beneficial microbial and invertebrate agents and pheromones. It has earned an enviable reputation for impartial, factual accuracy on the properties and uses of the many compounds that have been developed and marketed over the years as pesticides or enhancers of their effectiveness.

The agrochemical industry continues to make an enormous contribution to world food production and human welfare, and there is a continuing need for an up-to-date, authoritative and definitive source of information on all available pesticides, including their environmental impact. This eleventh edition of *The Pesticide Manual*, again produced and published solely by the British Crop Protection Council, provides an enormous amount of extremely useful data in a compact, concise and conveniently arranged form. It now includes improved coverage of ecotoxicological, degradation and environmental data to comply with the evolving EC and EPA regulatory requirements.

The editor and his colleagues at the British Crop Protection Council have further refined this scholarly work. It remains indispensable to all manufacturers, organisations, researchers, legislators, regulators, even journalists and private individuals with a professional interest in food and water quality and purity, in land use for forestry, farming, horticulture and recreation, and in conservation of terrestrial and aquatic flora and fauna. I strongly recommend this new edition to all previous buyers, and to new readers who need to be acquainted with the details of crop protection agents and their use.

Trevor Lewis
Lawes Trust Senior Fellow, Rothamsted
Formerly Director
Institute of Arable Crops Research, UK

THE PUBLISHER

This eleventh edition of *The Pesticide Manual* is published by the British Crop Protection Council (BCPC) - a registered charity. Formed in 1967, the principle objective of the BCPC is 'to promote and encourage the science and practice of crop proection for the benefit of all.'

BCPC brings together a wide range of organisations interested in the improvement of crop protection. The 43 members of the Board represent the interests of government departments, the agrochemical industry, farmers' organisations, the advisory services and independent consultants, distributors, the research councils, agricultural engineers, environment interests, training and overseas development.

The corporate members of the BCPC currently are:

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Agricultural Engineers Association
Association of Applied Biologists
Association of Independent Crop Consultants
ATB-Landbase
Biotechnology and Biological Sciences Reseach Council
British Agrochemicals Association
British Institute of Agricultural Consultants
British Society for Plant Pathology
British Society of Plant Breeders
Department of Agriculture for Northern Ireland
Department of the Environment
Ministry of Agriculture, Fisheries and Food
- Pesticides Safety Directorate
National Association of Agricultural Contractors
National Farmers' Union
Natural Environment Research Council
Overseas Development Administration
Scottish Office Agriculture, Environment and Fisheries Department
Society of Chemical Industry - The Pesticides Group
United Kingdom Agricultural Supply Trade Association

To obtain further information about the BCPC, its activities, conferences or publications, please contact:

The General Secretary, British Crop Protection Council, 49 Downing Street, Farnham, Surrey GU9 7PH, UK

Tel: +44 (0)1252 733072 Fax: +44 (0)1252 727194
Email: gensec@BCPC.org Internet: http://www.BCPC.org

EDITORIAL ADVISORY BOARD

An informal Editorial Advisory Board met to consider strategy and content for this edition of *The Pesticide Manual*. Thanks are due to them for many ideas and suggestions. Those attending were:

David Alford, ADAS
Duncan Batty, IACR-Rothamsted
Geoff Briggs, AgrEvo UK Ltd
Richard Bromilow, IACR-Rothamsted
David Cartwright, Zeneca Agrochemicals
John Caseley, IACR-Long Ashton
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John Mumford, Imperial College, University of London
Roger Thornely, AgrEvo UK Ltd
Trevor Lewis, BCPC
Frances McKim, BCPC
Len Copping
Hamish Kidd, Royal Society of Chemistry

Written contributions were received from:
Keith Brent
John Dowsett, DowElanco Ltd
Andy Hart, Central Science Laboratory
Derek Hollomon, IACR-Long Ashton
Trevor Martin, Bayer plc
David Martin, MAFF
Richard Rees, AgrEvo GmbH
Dale Shaner, American Cyanamid Co.
Mike Upstone, Du Pont (UK) Ltd.

PREFACE

After three years of preparation, another edition of *The Pesticide Manual* is complete.

This eleventh edition contains over 30 more Main Entries than its predecessor. As well as many new molecules, I have also included for the first time some important pheromones, and more biological agents.

I have been able to include more detail on biochemistry and mode of action and more of the entries now have ecotoxicological data. An indication of application rates has been restored to this edition. Much toxicological and physico-chemical data has again been revised with new data supplied by manufacturers. New fields of information include Henry's constant (a measure of air/water partitioning), risk phrases and EEC numbers. I have changed the layout of some entries to give more emphasis to the ester or other form of commercial relevance.

The Guide to Main Entries has been further extended. The resistance surveys, introduced in the previous edition, have been updated and the Glossary of Species has been revised.

This edition would not have been possible without the help of many other people. I would like to thank Denise Ledgerwood and Douglas Hartley for their excellent and painstaking work checking the proofs, David Alford, George Cussans and David Yarham for their extensive revisions to the Glossary, Richard Bromilow for much useful advice on pKa and partition coefficients, Paul Lister for programming work, and my colleagues in BCPC for their support and advice throughout.

Finally, I would especially like to thank the many people in companies around the world who took so much trouble to provide the data which makes up the majority of this book.

Despite all these invaluable helpers, any errors in transcription, interpretation or abbreviation are of course my responsibility. I should be grateful if readers would let me know of errors or omissions, which can be rectified in future editions.

Clive Tomlin, *Editor*

GUIDE TO USING THE MAIN ENTRIES

Further details on many fields of information are given under the appropriate heading in the Notes to the Sample Entry, which follow.

The example entry illustrates a chemical substance which is used in its ester form, but which receives its approved common name for its parent (acid) form.

1. Sequential entry number.
2. Entry header. The preferred name for the active ingredient parent molecule. For details, see Notes to the Sample Entry.
3. Class. See Notes to the Sample Entry.
4. Chemical structure. See Notes to the Sample Entry.
5. Headers in italics refer to the different forms (ester/acid, salt/acid, etc.) for which data are given.
6. Common name. The data in parentheses list those standards organisations that have approved the preceding common name. For details, see Notes to the Sample Entry. See Abbreviations and Codes for the meaning of the acronyms.
7. IUPAC name. See Notes to the Sample Entry.
8. Chemical Abstracts name. See Notes to the Sample Entry.
9. Chemical Abstracts Service Registry Number. See Notes to the Sample Entry.
10. EEC no. See Notes to the Sample Entry.
11. Development codes. See Notes to the Sample Entry.
12. Official codes (fictional example). See Notes to the Sample Entry.
13. Composition. Purity of technical grade, isomer composition, etc. For details, see Notes to the Sample Entry.
14. Molecular weight. Given to one decimal place.
15. Molecular formula. Given in the order C,H, alphabetical.
16. Form. The physical form, appearance and odour (if any) of the active ingredient.
17. Melting point.
18. Boiling point (fictional example).
19. Vapour pressure. See Notes to the Sample Entry.
20. Partition coefficient between *n*-octanol and water (as the log value). For details, see Notes to the Sample Entry.
21. Henry's constant. See Notes to the Sample Entry.
22. Specific gravity, density, relative density or bulk density.
23. Solubility. Units are not repeated after every value, but may be found in parentheses at the end of a sentence, together with other data, where available, such as the temperature, the pH (for solubility in water) and the method used.
24. Flash point (fictional example).
25. Other physical properties (fictional example).

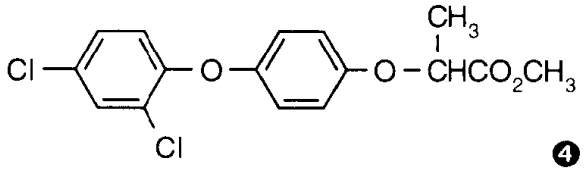
SAMPLE ENTRY

Note: This specimen entry has been deliberately shortened and modified (some items are fictitious, for example only) so that it illustrates the principles. It is **not** the same as the entry for diclofop-methyl.

❶ ❷ ❸

219 diclofop-methyl *Herbicide*

2-(4-aryloxyphenoxy)propionic acid



❹

NOMENCLATURE

❺ *diclofop-methyl*

❾ **CAS RN** *[51338-27-3]* unstated stereochemistry; *[71283–65–3]* (*R*)- isomer; *[75021-72-6]* (*S*)- isomer ❿ **EEC no.** 257-141-8 ⓫ **Development codes** Hoe 023408; AE F023408

❺ *diclofop*

❻ **Common name** diclofop (BSI, E-ISO, (*m*) F-ISO, ANSI, WSSA)

❼ **IUPAC name** (*RS*)-2-[4-(2,4-dichlorophenoxy)phenoxy]propionic acid

❽ **Chemical Abstracts name** (±)-2-[4-(2,4-dichlorophenoxy)phenoxy]propanoic acid

Other names Oname ❾ **CAS RN** *[40843–25–2]* unstated stereochemistry

⓫ **Development codes** Hoe 021079 ⓬ **Official codes** OMS 9999

PHYSICAL CHEMISTRY

diclofop-methyl

⓭ **Composition** Tech. grade is ≥93% pure. ⓮ **Mol. wt.** 341.2 ⓯ **M.f.** $C_{16}H_{14}Cl_2O_4$ ⓰ **Form** Colourless crystals. ⓱ **M.p.** 39–41 °C ⓲ **B.p.** 176 °C/0.5 mmHg

⓳ **V.p.** 0.25 mPa (20 °C) ... ⓴ **K_{ow}** logP = 4.58 ㉑ **Henry** ... ㉒ **S.g./density** 1.30 at 40 °C ㉓ **Solubility** In water 0.8 mg/l (pH 5.7, 20 °C). In acetone, dichloromethane, dimethyl sulfoxide, ethyl acetate, toluene >500 g/l; in polyethylene glycol 148, methanol 120, isopropanol 51, *n*-hexane 50 (all in g/l, 20 °C). **Stability** Stable to light. In water, DT_{50} (25 °C) 363 d (pH 5), 31.7 d (pH 7), 0.52 d (pH 9). **Specific rotation** ... ㉔ **F.p.** 165 °C (Tag open cup)

㉕ **Other properties** Tech. grade viscosity 15.7 mN/m (30 °C).

GUIDE TO USING THE MAIN ENTRIES

continued

26. pKa. Acid dissociation constant. See Notes to the Sample Entry.
27. No parent or derivative header. In these sections of an entry, it is usually not appropriate to distinguish whether data which follow apply to parent or derived form.
28. Patents. See Notes to the Sample Entry. WIPO country codes are used (see Abbreviations and Codes).
29. Manufacturer. The intention is that this should list only companies known to be manufacturing the active ingredient. In some cases, however, it may be that actual manufacture is carried out by a third party acting under contract to the named company.
30. Mode of action. The observed symptoms, and the physiology of the method by which the substance is effective.
31. Uses. See Notes to the Sample Entry.
32. Phytotoxicity. Any adverse effects on crops are listed. If the material is not phytotoxic, this is not normally noted.
33. Formulation type. For standard formulation types, the two-letter GCPF (formerly GIFAP) codes (see Abbreviations and Codes) are given. Some descriptions are too vague to allow conversion to a specific GCPF code, and have been left as full text.
34. Compatibility. Known incompatibilities with other pesticides, fertilisers or formulation adjuvants are given.
35. Selected tradenames. See Notes to the Sample Entry.
36. Analysis. See Notes to the Sample Entry.
37. IARC and EHC (fictional examples). See Notes to the Sample Entry.
38. Acute oral toxicity. Data are given in mg of active ingredient per kg of animal body weight.
39. Skin and eye. See Notes to the Sample Entry.
40. Acute inhalation toxicity. See Notes to the Sample Entry.
41. No Observable Effect Level. See Notes to the Sample Entry.
42. ADI. Acceptable daily intake (modified data). See Notes to the Sample Entry.
43. Toxicity class. See Notes to the Sample Entry.
44. EC Risk. See Notes to the Sample Entry.
45. PIC. See Notes to the Sample Entry.
46. Toxicology reviews. See Notes to the Sample Entry.

diclofop

⓮**Mol. wt.** 327.2 ⓯**M.f.** $C_{15}H_{12}Cl_2O_4$ ⓰**Form** Yellowish-white solid. ⓱**M.p.** 118-122 °C ⓳**V.p.** 3.1 × 10^{-6} mPa (20 °C) ... ⓴**K_{ow}** logP = 2.81 (pH 5), 1.61 (pH 7) **S.g./density** 1.4 (20 °C) ㉓**Solubility** In water 0.453 (pH 5), 122.7 (pH 7), 127.4 (pH 9) (all in g/l, 20 °C) ㉖**pKa** 3.43

㉗COMMERCIALISATION

History Herbicidal activity of diclofop-methyl reported by ... Introduced by Hoechst AG (now AgrEvo GmbH). ㉘**Patent** DE 2136828; DE 2223894 ㉙**Manufacturers** AgrEvo; Jingma

APPLICATIONS

diclofop-methyl

Biochemistry Fatty acid synthesis inhibitor. Destroys the cell membrane, ... ㉚**Mode of action** Diclofop-methyl is a selective systemic herbicide, also with contact action ... ㉛**Uses** Diclofop-methyl is used for post-emergence control of wild oats ... ㉜**Phytotoxicity** Phytotoxic to maize, sorghum, oats, sugar cane, rice, and cotton. ㉝**Formulation types** EC. **Mixtures** *(diclofop-methyl +)* fenoxaprop-P-ethyl. ㉞**Compatibility** Incompatible with most other herbicides. ㉟**Selected tradenames** 'Hoegrass' (AgrEvo); 'Hoelon' (AgrEvo); 'Illoxan' (AgrEvo)

㉗ ㊱ANALYSIS

Product analysis by glc (*CIPAC Handbook*, 1985, **1C,** 2096). Details of glc methods for **product** and **residue** analysis are available from AgrEvo.

MAMMALIAN TOXICOLOGY

diclofop-methyl

㊲**IARC** 999 **EHC** 999 ㊳**Oral** Acute oral LD_{50} for rats 481-693 mg/kg (in sesame oil), dogs 1600 mg/kg (highest dose without induction of vomiting). ㊴**Skin and eye** Acute percutaneous LD_{50} for rats >5000 mg/kg. ㊵**Inhalation** LC_{50} for rats >1.36 mg/l air. ㊶**NOEL** (2 y) for rats 0.1 mg/kg b.w.; (15 mo) for dogs 0.44 mg/kg b.w. ㊷**ADI** 0.001 mg/kg b.w. **Other** Non-mutagenic in the Ames test. ㊸**Toxicity class** WHO (a.i.) III; EPA (formulation) III ㊹**EC risk** Xn (R22, R43) ㊺**PIC**

diclofop

㊻**Reviews** *Pesticide residues in food - 1995*, FAO ... ㊳**Oral** Acute oral LD_{50} for female rats 586 mg/kg.

GUIDE TO USING THE MAIN ENTRIES

continued

47. Other beneficial species (fictional example).
48. Daphnia. Where no species name is given, data are for *D. magna*. In this example, the EC_{50} for *Daphnia magna*, exposed for 48 hours, is 0.23 mg a.i. per litre of water.
49. Other aquatic species (fictional example)
50. Animals and Plants. The fate of material applied to test species. Data supplied by manufacturers have often been summarised.
51. Soil/Environment. See Notes to the Sample Entry.

ECOTOXICOLOGY

diclofop-methyl

Birds Acute oral LD_{50} for Japanese quail >10 000 mg/kg. Five-day dietary ... **Fish** LC_{50} (96 h) for rainbow trout 0.23 mg/l. **Bees** Non-toxic to bees under field conditions and application rate of 1.134 kg a.i./ha. **Worms** LC_{50} (14 d) for earthworms >1000 mg/kg soil, dry weight. ㊼**Other beneficial spp.** Not toxic to *Argsope argentata* (web-building spider), *Aleochara* sp. (staphylinid beetle) ... ㊽**Daphnia** LC_{50} (48 h) 0.23 mg/l. **Algae** EC_{50} (72 h) for *Scenedesmus subspicatus* 1.5 mg/l ... ㊾**Other aquatic spp.** LC_{50} (96 h) for mysid shrimp (*Mysidopsis bahia*) 5.7 mg/l ...

㉗ENVIRONMENTAL FATE

㊿**Animals** When fed to rats, diclofop-methyl is almost totally absorbed and then rapidly excreted ... ㊿**Plants** Diclofop-methyl is taken up rapidly and almost completely by plants, with little translocation ... ㊿**Soil/Environment** In soil, diclofop-methyl is metabolised to diclofop, which then undergoes further degradation to ...

NOTES TO THE SAMPLE ENTRY

GENERAL POINTS

Active ingredient. Except where otherwise indicated, all data refer to the active ingredient.

Units. To avoid repetition, units are frequently omitted where a sequence of data is given; the relevant units are placed at the end of the sentence or phrase. For example:

> "**Acute oral LD_{50}** for rats 250, rabbits 400, mice 300 mg/kg."

Company names. Company names are often given in a shortened form. The full name of the company, and an address, is given in the Directory of Companies, p. 1407.

Obsolete names. In the Main Entries, obsolete names are enclosed by brackets, e.g. [bencarbate].

HEADERS

Entry header. The preferred name for the active ingredient. For biological agents, the scientific name is used.

For chemicals, the ISO common name is used, where one exists. Failing that, the order of preference is:- a national approved common name (e.g. BSI, JMAF, etc), WSSA, BAN or ESA name, official code number, development code number, IUPAC chemical name.

Class. Also given in the heading are the field of use (herbicide, insecticide, etc), and the class of material.

Choice of the word used for a class name is somewhat arbitrary. Many of the names used here have common currency; in other cases, however, the name used is only one of several alternatives used by different groups of workers. The primary role of class names is to group chemicals according to their known, or assumed, biochemical mode of action, and by common chemical features; such grouping is, however, neither immutable nor infallible.

Often the type of chemical is also indicated by a stem in the common name (for example, 'uron' for ureas, and 'carb' for carbamates).

Chemical structure. Structures have been drawn giving first priority to clarity of presentation, the illustrator using artistic licence over the orientation and length of bonds, etc., in order to keep the structures within a reasonable area.

As far as possible, the structures have been drawn so as to show the three-dimensional aspect, when this is known, so that the reader can see that some groups are in the plane of the paper, with others above or below it. When compounds contain a mixture of stereoisomers, a single drawing may be given, with no representation of the stereochemistry of the individual components.

NOMENCLATURE

Common name and **Standard.** Most chemical pesticides have common names agreed by the International Organisation for Standardization through its Technical Committee 81 (ISO/TC 81) for which the secretariat is the British Standards Institution (BSI). The principles for coining these common names are explained in ISO 257: 1988 and in BS1831: Part 1: 1985.

If the molecule is, for example, an acid, it may be used in a salt or ester form. Usually the common name is assigned to the parent acid; from this name, the salt or ester name can be derived in a straightforward manner by adding the name of the ester or ion (e.g. diclofop, diclofop-methyl). Short form names are used for some ions and ester groups. These are indicated in the Abbreviations and Codes Section, p. 1425.

Names are not formally approved by ISO until they appear in a list issued by ISO. However, the last supplement to the list of ISO-approved names appeared in 1983. As names achieve draft ISO status rather more rapidly, a status earlier in the approval process has been accepted, that of Provisionally Approved ISO name; this is indicated in the Pesticide Manual as 'pa ISO'.

In practice, there are usually two ISO names; one in English (designated E-ISO) and one in French (designated F-ISO, with gender indicated as (*m*) or (*f*)). Note that the French ISO name is that used in French-speaking countries, with the significant exception of France itself. Names approved by the French standards organisation, AFNOR, are not necessarily the same as F-ISO ones.

IUPAC name, Chemical Abstracts name. The systematic chemical names are given, according to the rules of the International Union of Pure and Applied Chemistry, and of the 9th Collective Index period of the Chemical Abstracts Service, respectively.

The systems of nomenclature for molecules which can form stereochemically differing isomers can be complex. However, to appreciate the isomeric composition of such materials where described in the entries, an understanding of these systems is essential. For details, see the Stereochemistry Nomenclature Section, p. xxiii.

Scientific name. For biological agents, the Latin name of the organism. Synonyms may be included under **Other names.**

CAS RN. The Chemical Abstracts Service Registry Number, a useful unique reference number. Under the Chemical Abstracts system, differing isomers, including stereoisomers, are assigned different Registry Numbers. For example, the (*R*) and (*S*) optical isomers, as well as the (*RS*) racemic mixture, and material of undefined stereochemistry will, if they have been described in the chemical literature, all have different Registry Numbers. Further details are given in the introduction to Index 1.

EEC no. Number in the European Inventory of Existing Chemical Substances (EINECS) or in the European List of Notified (New) Chemicals (ELINCS).The EINECS Inventory lists and defines those chemical substances which were on the European Community market between 1 January 1971 and 18 September 1981, and to which the pre-marketing notification provisions of Amendment VI to the Directive 67/548/EEC do not apply. The final version was published in June 1990, in the Official Journal of the EC. ELINCS lists substances notified since EINECS was completed. The absence of information under this heading does not necessarily imply that the substance is not in one of these European lists.

Development codes. Code number usually assigned before the material was given a common name. In some cases, the name of the company is also given; this is the name of the company which actually developed the material, not necessarily the same as the name of the company which now markets it. For this reason, some of these names are of companies which are no longer involved in pesticides, and they may not appear in the Directory of Companies.

Official codes. These include numbers assigned by WHO (OMS series), the Entomological Society of America (ENT and AI3 series) and the American Society of Nematologists (AI4 series).

PHYSICAL CHEMISTRY

Composition. Technical grade (abbreviated 'tech.') material is used in practice. This is usually of a defined minimum purity, details of which are given here. Where a substance is capable of existing in different stereochemical forms (see **Chemical structure** and the Stereochemistry Nomenclature Section, p. xxiii), the material used may be a single stereochemical isomer, or a mixture of isomers. An attempt has been made to clarify what isomer or mixture of isomers is used; this does not always correspond to the isomers present in the common name as defined.

Vapour pressure. Values quoted in alternative sources can differ by several orders of magnitude; factors affecting determined vapour pressure values include temperature, purity and method of determination. Where differing values were available, the lowest figure has been chosen. In general, vapour pressures which were known to be those of technical material have not been quoted. In those few cases where a value without a

temperature was supplied, it is left to the reader to decide whether or not to assume the determination was at room temperature. Manufacturers were also asked to supply the method of determination; where given, this is appended in parentheses. Most values have been converted to milliPascals (mPa).

1 mPa is equivalent to c. 7.50×10^{-6} mmHg or torr, 10^{-8} bar or 9.87×10^{-9} atm.

Partition coefficient. A high value for the partition coefficient (P) between *n*-octanol and water is regarded as an indicator that a substance will bio-accumulate (unless other factors operate). Values are given as logP. Note that, for molecules that dissociate, logP values measured within 3 pH units of the pKa will represent an average value over two or more forms present.

Henry's constant. The tendency of a material to volatilise from aqueous solution to air. Sometimes measured, more usually calculated as the ratio of vapour pressure (in Pascals) × molecular weight / solubility (mg/l).

pKa. Strengths of acids and bases are indicated on a common scale (use of pKb for bases being no longer used widely). Where no pKa value is given, it may indicate that no significant dissociation occurs in the environmental range; values of pKa <4 for bases and pKa >8 for acids are not relevant in an environmental context.

COMMERCIALISATION

Patent. Usually only one patent or patent application is cited; patent applications or patents to the same invention in other countries will usually exist. Note that any protection afforded by any of the patents listed may have expired. A patent will not necessarily protect the active ingredient or its use as a pesticide; there may be a series of patent applications relating to the active ingredient, its manufacture, formulation or its use.

Company names refer to the original applicant; title to patents (as distinct from rights to it) may not be transferred when a product or company is bought by another company. For this reason, some company names given here are of ones no longer in the pesticides business.

Country codes are WIPO standard; see the Abbreviations and Codes Section, p. 1427.

APPLICATIONS

Uses. Crop names are in English; targets are given in either Latin or English. A Glossary of Latin and English names is included in *The Pesticide Manual*. Where British and American usage differs, alfalfa (lucerne), and peanuts (groundnuts) have been selected,