

**

Chlorpyrifos

Review Technical Report

December 2023

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Preface

The Australian Pesticides and Veterinary Medicines Authority (APVMA) is an independent statutory authority that administers the National Registration Scheme for Agricultural and Veterinary Chemicals. The APVMA evaluates, registers and regulates agricultural and veterinary (agvet) chemicals up to the point of sale. The states and territories are responsible for control of use. Its statutory powers are provided in the Agricultural and Veterinary Chemicals Code (the Agvet Code), which is scheduled to the *Agricultural and Veterinary Chemicals Code* *Act 1994*.

The APVMA has legislated powers to reconsider the approval of an active constituent, registration of a chemical product or approval of a label at any time after it has been registered. The reconsideration process is outlined in sections 29 to 34 of Part 2, Division 4 of the Agvet Codes. The Code provides for the suspension and cancellation of approvals and registrations if it appears to the APVMA that the criteria for approval or registration are not, or are no longer, satisfied (s 41 and s 44 of Part 2, Division 5).

A reconsideration may be initiated when new research or evidence has raised concerns about the use or safety of a particular chemical, a product containing that chemical, or its label. The scope of each reconsideration can cover a range of areas including human health (toxicology, public health, work health and safety), the environment (environmental fate and ecotoxicology), residues and trade, chemistry, efficacy or target crop or animal safety. However, the scope of each reconsideration is determined on a case-by-case basis reflecting the specific issues raised by the new research or evidence.

The reconsideration process includes a call for data from a variety of sources, a scientific evaluation of that data and, following public consultation, a regulatory decision about the ongoing use of the chemical or product. The data required by the APVMA must be generated according to scientific principles. The APVMA conducts scientific and evidence-based risk analysis with respect to the matters of concern by analysing all the relevant information and data available.

About this document

This Technical Report is intended to provide an overview of the assessments that have been conducted by the APVMA and of the specialist advice received from its advisory agencies. It has been deliberately presented in a manner that is likely to be informative to the widest possible audience, thereby encouraging public comment.

This document contains a summary of the assessment reports generated in the course of the chemical review of an active ingredient, including the registered product and approved labels. The document provides a summary of the APVMA’s assessment, which may include details of:

* the toxicology of both the active constituent and product
* the residues and trade assessment
* occupational exposure aspects
* environmental fate, toxicity, potential exposure and hazard
* efficacy and target crop or animal safety.

# Introduction

Chlorpyrifos is a broad spectrum, non-systemic organophosphate insecticide approved for use in a wide range of agricultural, horticultural, commercial and veterinary situations. The APVMA commenced a reconsideration of chlorpyrifos active constituent approvals, product registrations and associated label approvals under Part 2, Division 4 of the Agvet Code in 1996. Chlorpyrifos was nominated for reconsideration in 1994 due to possible risks associated with work health and safety, residues in food and to the environment.

The APVMA published interim component assessment reports ([chemistry](https://apvma.gov.au/node/19616), [toxicology](https://apvma.gov.au/node/14746), [occupational health and safety](https://apvma.gov.au/node/14751), [environment](https://apvma.gov.au/node/14756) and [residues, trade and efficacy](https://apvma.gov.au/node/14741)) in 2000. As a result, several regulatory measures were implemented, including cancellation of home use products containing more than 50 g/L chlorpyrifos together with label amendments with updated directions for use, first aid instructions and safety directions, and environmental warning statements for domestic and agricultural products.

The APVMA published additional interim component assessment reports (including [residues and trade](https://apvma.gov.au/node/14761), [toxicology](https://apvma.gov.au/node/26831), [a toxicology update](https://apvma.gov.au/node/50111), [environment](https://apvma.gov.au/node/50116) and [residential exposure](https://apvma.gov.au/node/50121)) in 2009, 2017 and 2019. As a result of the assessment outcomes, the APVMA cancelled all home garden and domestic uses of chlorpyrifos in 2019, as well as the registrations for products with only those uses on the label. More information is available in the [Special Gazette of 24 June 2019](https://apvma.gov.au/node/50096).

The remaining components of reconsideration of chlorpyrifos active constituent approvals, product registrations and associated label approvals (hereafter referred to the chlorpyrifos chemical review) specifically relate to the use of chlorpyrifos in agricultural, horticultural, commercial and veterinary situations.

## Purpose of review

The scope of the chlorpyrifos chemical review includes the following aspects of active constituent approvals, product registrations and label approvals for chlorpyrifos:

* Worker health and safety:
* Risks to professional workers arising from exposure during handling and application.
* Risks to professional workers who re-enter treated areas or re-handle treated material.
* Determination of appropriate personal protective clothing and engineering control requirements.
* Establishment of appropriate first aid instructions and safety directions for chlorpyrifos products.
* Residues and trade:
* Residues in treated food and animal feeds arising from application in accordance with label instructions.
* Establishment of appropriate maximum residue limits (MRLs) for supported uses of chlorpyrifos.
* Determination of dietary exposure resulting from the consumption of produce treated with chlorpyrifos.
* Risks to international trade resulting from the use of chlorpyrifos on major export commodities.
* Environment
* Risks to terrestrial vertebrates, aquatic species, bees, other non-target arthropods, soil organisms and terrestrial plants resulting from application in accordance with label instructions.

The APVMA has also considered information pertaining to the chemistry (minimum active purity and impurities of toxicological concern) and toxicology (health-based guidance values and poison scheduling).

In addition to the above assessments, chlorpyrifos labels were reviewed for consistency with current APVMA policies and guidelines, including the [Agricultural Labelling Code](https://apvma.gov.au/registrations-and-permits/labelling-codes), [Veterinary Labelling Code](https://apvma.gov.au/taxonomy/term/18561) and [APVMA Spray Drift Policy July 2019](https://apvma.gov.au/node/10796).

## Mode of action, product claims and use patterns

Chlorpyrifos is a broad spectrum, non-systemic organophosphate insecticide with contact, stomach and respiratory action. Chlorpyrifos acts through the inhibition of acetyl cholinesterase (AChE), an enzyme that is important for the transmission of nerve signals.

Products containing chlorpyrifos are used extensively in Australian agriculture to control a variety of insect pests in field crops, fruits, vegetables, turf, ornamentals, and pastures. It is also used for the control of termites and other pests in commercial establishments and in certain public spaces.

Agricultural application is mainly by ground application using boom spray onto foliage or as a soil-based application, aerial application (e.g. banana, cotton), drenching (e.g. the base of fruit trees), baiting and seed dressing. Termite control is as a pre-construction soil application (for which it is listed as a Restricted Chemical Product under Schedule 4 of the Agvet Code Regulations) or as post-construction application through soil injection and barrier sprays. There are also limited uses of veterinary ear tags for the control of some animal pests.

## International regulatory status

Chlorpyrifos has recently been considered by international regulators, including the United States Environmental Protection Agency (US EPA), the European Commission, Health Canada’s Pest Management Regulatory Agency (PMRA) and the Codex Alimentarius Commission (which is the joint Food and Agriculture Organization and the World Health Organization’s food standards program).

### United States

The US EPA made a decision to end the use of chlorpyrifos on food crops in August 2021. To this effect, all tolerances for residues of chlorpyrifos on food commodities were revoked as of 28 February 2022. The non-food uses of chlorpyrifos were not impacted by these decisions, and use of chlorpyrifos in non-food situations such as for pest control in commercial establishments, industrial sites, non-food plantations and turfgrass are still permitted.

### European Union

As of 10 January 2020, the approval of chlorpyrifos was not renewed in the European Union (EU). Member States were to withdraw authorisations for plant protection products containing chlorpyrifos as an active substance by 16 February 2020, with a grace period not extending beyond 16 April 2020. Further, in 2020 the EU also replaced their maximum residues limits (MRLs) for chlorpyrifos with a default value of 0.01 mg/kg (the level of quantification).

### Canada

The PMRA made the decision to cancel most uses of chlorpyrifos ([RVD2020-14](https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/decisions-updates/reevaluation-decision/2020/chlorpyrifos.html)) on 10 December 2020 and decided to cancel all remaining uses of chlorpyrifos on 13 May 2021, with the decision reissued ([REV2021-04](https://www.canada.ca/en/health-canada/services/consumer-product-safety/reports-publications/pesticides-pest-management/decisions-updates/reevaluation-note/2021/cancellation-remaining-chlorpyrifos-registrations.html)) on 21 December 2021. Sales by the registrant were cancelled immediately, with sales by retailers cancelled as of 10 December 2022 and use of chlorpyrifos products allowed until 10 December 2023.

### Codex Alimentarius Commission

The Codex Alimentarius Commission (Codex) is responsible for establishing Codex Maximum Residue Limits (CXLs) for pesticides. Codex CXLs are primarily intended to facilitate international trade and accommodate differences in Good Agricultural Practice (GAP) employed by various countries. The Codex Committee on Pesticide Residues at its 53rd meeting in July 2022 ([REP22/PR53](https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-718-53%252FREPORT%252FFINAL%2BREPORT%252FREP22_PR53e.pdf)) agreed to revoke all Codex MRLs as a public health concern was expressed and data requested by the Joint Meeting on Pesticide Residues to complete its risk assessment was not available.

# Chemistry

## Active constituents

Table 1: Nomenclature and structural formula of the active constituent chlorpyrifos[[1]](#footnote-2)

| Parameter | Nomenclature and structure |
| --- | --- |
| Common name (ISO) | Chlorpyrifos |
| IUPAC name | *O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate |
| CAS registry number | 2921-88-2 |
| Molecular formula: | C9H11Cl3NO3PS |
| Molecular weight: | 350.6 gmol-1 |
| Structural formula: | Visual representation of the structural formula of the active constituent chlorpyrifos |

Technical chlorpyrifos takes the form of colourless crystals with a mild mercaptan odour at room temperature and normal atmospheric pressure. It is slightly volatile, and has very low solubility in water, while being highly soluble in most polar organic solvents and aromatic hydrocarbon solvents. Chlorpyrifos undergoes aqueous photolysis fairly rapidly, with a half-life of 30 days estimated under summer sunlight at 40 °C. It is hydrolysed with half-life of 72 days at pH 5 and pH 7 at 25 °C and is more rapidly hydrolysed at alkaline pH (16 days at pH 9 and 25 °C). Further details of the physicochemical properties are tabulated below (Table 2).

Table 2: Key physicochemical properties of the active constituent chlorpyrifos[[2]](#footnote-3),[[3]](#footnote-4)

| Parameter | Physicochemical property |
| --- | --- |
| Appearance: | Technical active constituent: colourless crystals with a mild mercaptan odour |
| Melting point: | 42–43.5°C |
| Boiling point: | >400°C |
| Specific gravity: | 1.44 (20 °C) |
| Stability: | Stable for at least 2 years storage under normal conditions |
| Solubility in water: | ~1.4 mg/L (25 °C) |
| Organic solvent solubility (g/kg, 25°C): | Acetone: 6,500  Benzene: 7,900  Chloroform: 6,300  Carbon disulfide: 5,900  Diethyl ether: 5,100  Xylene: ,5000  Iso-octanol: 790  Methanol: 450 |
| Octanol/water partition coefficient (Log Kow): | 4.7 |
| Vapour pressure: | 2.7 mPa (25 °C) |
| Henry’s law constant: | 0.676 Pa.m3mol-1 |
| Hydrolysis: | Rate of hydrolysis is independent of pH below pH 7, with a half-life of 72 days at 25 °C in sterile buffered water. Hydrolysis is more rapid at alkaline pH, with a half-life of 16 days at pH 9. |
| Aqueous photolysis: | Photolysis of chlorpyrifos is fairly rapid, with 3,5,6-trichloro-2-pyridinol (TCP) as the main product. The average aqueous photolysis half-life of chlorpyrifos under midsummer conditions at 40 °C is about 30 days. TCP has a predicted photolysis half-life of 15 minutes based on a quantum yield study. |

There are currently 30 active constituent approvals for chlorpyrifos, which are listed in Table 3 below.

Table 3: Current active approvals for chlorpyrifos

| Approval number | Approval holder |
| --- | --- |
| 44005 | ADAMA Australia Pty Limited |
| 44111 | Corteva Agriscience Australia Pty Ltd |
| 44112 | Corteva Agriscience Australia Pty Ltd |
| 44113 | Corteva Agriscience Australia Pty Ltd |
| 44160 | Corteva Agriscience Australia Pty Ltd |
| 46888 | Gharda Australia Pty Ltd |
| 47155 | Sumitomo Chemical Australia Pty Ltd |
| 48521 | FMC Australasia Pty Ltd |
| 49124 | Corteva Agriscience Australia Pty Ltd |
| 49340 | Corteva Agriscience Australia Pty Ltd |
| 50886 | Imtrade Australia Pty Ltd |
| 55457 | Agrogill Chemicals Pty Ltd |
| 56174 | Corteva Agriscience Australia Pty Ltd |
| 58019 | Coromandel Australia Pty Ltd |
| 60079 | Agrogill Chemicals Pty Ltd |
| 62025 | Huilong Agrochemicals Australia Pty Ltd |
| 64006 | Netmatrix Crop Care Limited |
| 65331 | Nutrien Ag Solutions Limited |
| 65346 | Imtrade Australia Pty Ltd |
| 65403 | Sinon Australia Pty Ltd |
| 67013 | Sharda Worldwide Exports Pvt Ltd |
| 67331 | Agroshine Australia Pty Ltd |
| 70330 | Zhejiang Hengdian Imp. & Exp. Co Ltd |
| 70430 | Sabakem Pty Ltd |
| 80115 | Aimco Kr Australia Pty Ltd |
| 81656 | Sanonda (Australia) Pty Ltd |
| 82263 | Nutrien Ag Solutions Limited |
| 83860 | Crystal Crop Protection (Australia) Pty Ltd |
| 86105 | Krishi Rasayan Exports Pvt Ltd |
| 87692 | Lianyungang Liben Crop Science Co Ltd |

The chlorpyrifos standard in the [Agricultural and Veterinary Chemicals Code (Agricultural Active Constituents) Standards 2022](https://www.legislation.gov.au/Details/F2022L00137) specifies a minimum purity of 940 g/kg for the technical active constituent, with a maximum of 3 g/kg for the toxicologically significant impurity *O,O,O’,O’*-tetraethyl dithiopyrophosphate (S,S-TEPP).

Figure 1: Structure of O,O,O’,O’-tetraethyl dithiopyrophosphate (S,S-TEPP)

Visual representation of the structure of O,O,O’,O’-tetraethyl dithiopyrophosphate (S,S-TEPP)

The [Food and Agriculture Organization of the United Nations (FAO) specification](https://www.fao.org/3/ca8091en/ca8091en.pdf) for chlorpyrifos technical active constituent specifies a minimum purity of 970 g/kg, with a maximum of 3 g/kg for *O,O,O’,O’*-tetraethyl dithiopyrophosphate (FAO 2020). The minimum purity requirement for chlorpyrifos in this FAO full specification (i.e. 970 g/kg chlorpyrifos) is significantly higher than the minimum purity requirement in the prior 1984 FAO tentative specification (i.e. 940 ± 20 g/kg chlorpyrifos). Based on the available information, the APVMA is proposing to increase the minimum purity for the chlorpyrifos technical active constituent in the Agricultural Active Constituents Standard 2022 to 970 g/kg to align with the updated internationally accepted FAO full specification.

## Formulated products

There are currently 62 registered chemical products containing chlorpyrifos as the active constituent, which are listed in Table 4 below. These products are formulated as emulsifiable concentrates (EC), water-dispersible granules (WG), wettable powders (WP), granular formulations (GR), a slow release generator (SR) in the form of a bag to attach to banana bunches, and a chlorpyrifos-impregnated ear tag for use on cattle. Chlorpyrifos is the only active constituent in most of these registered products. There are 5 EC products that also contain the active constituent bifenthrin and one ear tag product that also contains the active constituent diazinon.

Table 4: Current registered products containing chlorpyrifos

| Registration number | Product name | Holder | Formulation type |
| --- | --- | --- | --- |
| 42284 | David Grays Chlorpyrifos 500 | David Gray & Co Pty Limited | EC – emulsifiable concentrate |
| 45486 | Strike-Out 500 EC Insecticide | ADAMA Australia Pty Limited | EC – emulsifiable concentrate |
| 49666 | Barmac Chlorpyrifos G Granular Insecticide | Amgrow Pty Ltd | GR – granular formulation |
| 49869 | 4Farmers Chlorpyrifos 500 Insecticide | 4 Farmers Australia Pty Ltd | EC – emulsifiable concentrate |
| 50387 | Titan Chlorpyrifos 500 Termiticide and Insecticide | Titan Ag Pty Ltd | EC – emulsifiable concentrate |
| 50416 | Suscon Green Soil Insecticide | Nufarm Australia Limited | GR – granular formulation |
| 50452 | Titan Chlorpyrifos PC 450 Insecticide | Titan Ag Pty Ltd | EC – emulsifiable concentrate |
| 51190 | Imtrade Chlorpyrifos 500 Insecticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |
| 51524 | Y-Tex Warrior Insecticidal Cattle Ear Tags | Nutrien Ag Solutions Limited | 1J – ear tag |
| 51875 | Pidgeon's Pest Controller 500 Termiticide and Insecticide | Pooma Fertilizers Pty Ltd | EC – emulsifiable concentrate |
| 53428 | Generifos 500EC Insecticide | Grow Choice Pty Limited | EC – emulsifiable concentrate |
| 54546 | Pyritilene Banana Bags | ADAMA Australia Pty Limited | SR – slow release generator (inc. flea collars) |
| 55213 | Kenso Agcare Kensban 500 Insecticide | Kenso Corporation (M) Sdn. Bhd. | EC – emulsifiable concentrate |
| 55755 | Surefire Fortune 500 Multi-Purpose Insecticide and Termiticide | PCT Holdings Pty Ltd | EC – emulsifiable concentrate |
| 55897 | Conquest Chlorpyrifos 500 Insecticide | Conquest Crop Protection Pty Ltd | EC – emulsifiable concentrate |
| 60188 | Genfarm Chlorpyrifos 500 Insecticide | Nutrien Ag Solutions Limited | EC – emulsifiable concentrate |
| 60611 | Huilong Chlorpyrifos 500 EC Insecticide | Huilong Agrochemicals Australia Pty Ltd | EC – emulsifiable concentrate |
| 61071 | Strike-Out 500 WP Insecticide | ADAMA Australia Pty Limited | WP – wettable powder |
| 62672 | Sabero Chlorpyrifos 500EC Insecticide | Coromandel Australia Pty Ltd | EC – emulsifiable concentrate |
| 63086 | Chemicide 500 Insecticide | Hextar Chemicals Pty Ltd | EC – emulsifiable concentrate |
| 63145 | AW Cuft 500 Insecticide and Termiticide | Agri West Pty Limited | EC – emulsifiable concentrate |
| 64319 | Farmalinx Chlorpos 500 EC Insecticide | Farmalinx Pty Ltd | EC – emulsifiable concentrate |
| 65160 | Apparent Dingo 500 Insecticide | Titan Ag Pty Ltd | EC – emulsifiable concentrate |
| 65556 | Rainbow Chlorpyrifos 500 Insecticide | Shandong Rainbow International Co Ltd | EC – emulsifiable concentrate |
| 66354 | Ozcrop Chlorpyrifos 500 EC Insecticide | Oz Crop Pty Ltd | EC – emulsifiable concentrate |
| 67451 | Sabakem Chlorpyrifos 500EC Insecticide | Sabakem Pty Ltd | EC – emulsifiable concentrate |
| 67887 | Spalding Chlorpyrifos 500 Insecticide | DGL Environmental Pty Ltd | EC – emulsifiable concentrate |
| 67984 | Ezycrop Chlorpyrifos 500 Insecticide | Ezycrop Pty Ltd | EC – emulsifiable concentrate |
| 68467 | Chlorban 500 EC Insecticide | UPL Australia Pty Ltd | EC – emulsifiable concentrate |
| 68574 | Accensi Micro-Lo Pre-Construction/Post-Construction Termiticide and Insecticide | Accensi Pty Ltd | EC – emulsifiable concentrate |
| 68575 | Accensi Pre-Construction/Post-Construction Termiticide and Insecticide | Accensi Pty Ltd | EC – emulsifiable concentrate |
| 68745 | AC Chop 500 Insecticide and Termiticide | Axichem Pty Ltd | EC – emulsifiable concentrate |
| 68781 | Pyrinex Super Insecticide/ Miticide | ADAMA Australia Pty Limited | EC – emulsifiable concentrate |
| 69048 | Smart Chlorpyrifos 500 Insecticide | Crop Smart Pty Ltd | EC – emulsifiable concentrate |
| 69671 | Agrocn Chlorpyrifos 500 EC Insecticide and Termiticide | Shanghai Agrochina Chemical Co. Ltd. | EC – emulsifiable concentrate |
| 69776 | Accensi Chlorpyrifos 500 Insecticide | Accensi Pty Ltd | EC – emulsifiable concentrate |
| 70410 | Pyrigran Insecticide | Sulphur Mills Australia Pty Limited | WG – water dispersible granule |
| 81735 | ACP Chlorpyrifos 500 Insecticide | Australis Crop Protection Pty Ltd | EC – emulsifiable concentrate |
| 81786 | Chlorphos 500EC Insecticide | Nutrien Ag Solutions Limited | EC – emulsifiable concentrate |
| 83386 | Sharda Chlorpyrifos 500 Insecticide | Sharda Cropchem Espana S.L | EC – emulsifiable concentrate |
| 83426 | Echem Chlorpyrifos 500 Insecticide | Echem (Aust) Pty Limited | EC – emulsifiable concentrate |
| 86189 | Sinon Chlorpyrifos 500 Insecticide | Sinon Australia Pty Limited | EC – emulsifiable concentrate |
| 86612 | Arysta Lifescience Chlorpyrifos 500 EC Insecticide | Arysta Lifescience Australia Pty Ltd | EC – emulsifiable concentrate |
| 87086 | Guangxin Chlorpyrifos 500 EC Insecticide | Anhui Guangxin Agrochemical Co Ltd | EC – emulsifiable concentrate |
| 88651 | Task 500 EC Insecticide | Hemani Industries Limited | EC – emulsifiable concentrate |
| 89019 | Kelpie Chlor-P 500 Insecticide & Termiticide | Sinochem International Australia Pty. Ltd. | EC – emulsifiable concentrate |
| 89312 | Delfos 5G Insecticide | Industrial Quimica Key, S.A. | GR – granular formulation |
| 89696 | Clip Insecticide | Sharda Cropchem Espana S.L | EC – emulsifiable concentrate |
| 89815 | Relyon Chlorpyrifos 500 Insecticide | Nutrien Ag Solutions Limited | EC – emulsifiable concentrate |
| 90087 | Imtrade Outperform 630 EC Insecticide/Miticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |
| 90088 | Imtrade Outplay 700 EC Insecticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |
| 90204 | Cropsure Sureban 500EC Insecticide | Cropsure Pty Ltd | EC – emulsifiable concentrate |
| 90392 | 4Farmers Chlorpyrifos 750 WG Insecticide | 4 Farmers Australia Pty Ltd | WG – water dispersible granule |
| 90395 | Cropsure Sureban 750WG Insecticide | Cropsure Pty Ltd | WG – water dispersible granule |
| 91024 | APS Chlorpyrifos 500 EC Insecticide | Agricultural Product Services Pty Ltd | EC – emulsifiable concentrate |
| 91222 | IA Outperform 630 EC Insecticide/Miticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |
| 91352 | Agmerch Chlorpyrifos 500 Insecticide | Agmerch Pty Ltd | EC – emulsifiable concentrate |
| 91672 | Imtrade Outperform 630 Veriphy EC Insecticide/Miticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |
| 91691 | Imtrade Outplay 700 Veriphy EC Insecticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |
| 92193 | Eurochem Chlorpyrifos 750 WG Insecticide | Eurochem Pty Ltd | WG – water dispersible granule |
| 92590 | IA Outplay 700 Veriphy EC Insecticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |
| 92594 | IA Outperform 630 Veriphy EC Insecticide/Miticide | Imtrade Australia Pty Ltd | EC – emulsifiable concentrate |

There are currently no standards for chlorpyrifos end use products established by the APVMA. The [FAO specification for chlorpyrifos](https://www.fao.org/3/ca8091en/ca8091en.pdf) includes specifications for EC and ultra-low volume (UL) chlorpyrifos products (FAO 2020). It is noted that these specifications include a limit for the toxicologically significant impurity O,O,O’,O’-tetraethyl dithiopyrophosphate at a maximum of 0.3% of the active content, which is the same as the active constituent chlorpyrifos. This impurity has not been observed to increase in formulated products during storage. The APVMA therefore remains satisfied of the impurity content of the products listed in Table 4, and is not proposing to establish a standard for end use chlorpyrifos products.

The proposed changes to the Agricultural Active Constituents Standard 2022 discussed in the [*Active constituents*](#_Active_Constituents) section above may result in minor formulation updates for registered products in Table 4 that have previously used a source of chlorpyrifos active constituent with a purity less than 970 g/kg (but greater than or equal to 940 g/kg). These formulation updates may include requiring a slightly lower amount of technical active as a result of a higher purity to give the product label claim, along with consequent minor adjustments to levels of other ingredients such as solvents or carriers.

## Chemistry recommendations

### Proposed amendment to the Agricultural and Veterinary Chemicals Code (Agricultural Active Constituents) Standards 2022 for chlorpyrifos

The current chlorpyrifos standard in the Agricultural Active Constituents Standards 2022 states the material shall consist of chlorpyrifos together with related manufacturing impurities and shall be a white to amber solid, with a mild mercaptan type (sulphur) odour, free from visible extraneous matter and added modifying agents and the minimum purity specified is 940 g/kg.

The current standard indicates the following acceptable levels of toxicological impurities:

* O,O,O’,O’-tetraethyl dithiopyrophosphate (S,S-TEPP): 3 g/kg maximum

It is recommended the Agricultural Active Constituents Standards 2022 for chlorpyrifos active constituent be amended, to increase the minimum purity specified from 940 g/kg to 970 g/kg as shown in Table 5.

Table 5: Proposed compositional requirements for chlorpyrifos active constituents

| Column A  Identification of the active constituent | Column B  Description | Column C  Minimum purity | Column D  Maximum impurity levels |
| --- | --- | --- | --- |
| **Common Name:** Chlorpyrifos **Chemical Name:** *O,O*-diethyl *O*-(3,5,6-trichloro-2-pyridyl) phosphorothioate **CAS Number:** 2921-88-2 | The material shall consist of chlorpyrifos together with related manufacturing impurities and shall be a white to amber solid, with a mild mercaptan type (sulphur) odour, free from visible extraneous matter and added modifying agents. | 970 g/kg minimum | *0,0,0',0'*-tetraethyl dithiopyrophosphate (S,S-TEPP): 3 g/kg maximum |

# Toxicology

## Previous assessments

An [updated toxicology assessment](https://apvma.gov.au/node/50111) was published by the APVMA in 2019 (APVMA 2019a), supplementing the [toxicology assessment report](https://apvma.gov.au/node/26831) published in 2017 (APVMA 2017).The scope of this 2019 updated toxicology assessment was to:

* evaluate the recent emergent published literature regarding the hypothesised adverse effects of low dose (doses below the threshold for inhibition of blood cholinesterases) chlorpyrifos treatment in vivo
* re-evaluate the regulatory studies supporting the current APVMA health-based guidance values for chlorpyrifos
* propose new APVMA health-based guidance values for chlorpyrifos.

The APVMA has reviewed the outcomes of the 2019 toxicology assessment, and the conclusion remains unchanged.

## Health-based guidance values

The proposed new health-based guidance values for chlorpyrifos were established by the APVMA in June 2019. This included an [acceptable daily intake](https://apvma.gov.au/node/26596) of 0.001 mg/kg bw/day and an [acute reference dose](https://apvma.gov.au/node/26591) of 0.03 mg/kg bw/day.

### Acceptable daily intake

The acceptable daily intake (ADI) for chlorpyrifos was established based on the recent series of studies in young and adult rats performed by DOW 2010[a] and Marty et al 2012. The no-observed-effect-level (NOEL) for inhibition of blood cholinesterases (erythrocyte cholinesterase as well as plasma cholinesterases) for rats from post-natal day 11 of age to adulthood was 0.1 mg/kg bw/day (consistently five-fold lower than the threshold for inhibition of brain cholinesterases in this species). This point of departure is supported by the following toxicological thresholds in other studies that have been evaluated by the agency (see Table 6).

Table 6: Toxicological thresholds in other studies

| Reference | Study type | No observed adverse effect level (NOAEL) | Comments |
| --- | --- | --- | --- |
| Szabo et al 1988 | 13-week repeat daily oral (dietary) dose toxicity study in F344 rats | 0.1 mg/kg bw/day based on inhibition of brain and erythrocyte cholinesterases at higher doses | Plasma and erythrocyte cholinesterase activities were decreased at doses ≥ 1 mg/kg bw/ day, and the activity of brain acetylcholinesterase was decreased at 5 and 15 mg/kg bw/day |
| Young and Grandjean 1988 | 2-year repeat daily oral (dietary) carcinogenicity study (OECD Test Guideline No. 451) in F344 rats | 0.1 mg/kg bw/day based on inhibition of erythrocyte and plasma cholinesterases at higher doses | NOEL for inhibition of brain cholinesterase was 1 mg/kg bw/day based on consistent, statistically significant (p < 0.05) inhibition at 10 mg/kg bw/day |
| Breslin et al 1991 | 2 generation reproductive toxicity study in SD rats | 0.1 mg/kg bw/d based on inhibition of blood cholinesterases at higher doses | NOAEL for inhibition of brain cholinesterase and maternal toxicity was 1 mg/kg bw/day. The NOAEL for developmental effects was 1 mg/kg bw/day, and the NOAEL for effects on fertility and reproductive effects was 5 mg/kg bw/day |

The ADI of 0.001 mg/kg bw/day is based on the NOEL of 0.1 mg/kg bw/day for inhibition of blood cholinesterases (blood acetyl- and butyrylcholinesterases) in rats in a repeat oral dose study, with a total intra- and inter-species uncertainty factor of 100 applied.

### Acute reference dose

The acute reference dose (ARfD) for chlorpyrifos was established based on the human acute, single dose NOEL for inhibition of plasma cholinesterase of 1 mg/kg bw derived from Kisicki et al 1999. This point of departure is supported by the NOEL of 0.5 mg/kg bw for inhibition of blood cholinesterases in rats (Marty et al 2012).

The APVMA elected to apply the full ten-fold intra-species uncertainty factor for calculating the ARfD. Since the point of departure was determined in humans, an inter-species uncertainty factor is not required. However, because of the statistical power limitations (small n compared with modern human clinical trial standards) and other concerns associated with the Kisicki et al 1999 study, the APVMA applied an additional uncertainty factor of 100.5-fold to account for any remaining uncertainties. The total uncertainty factor applied is thus 10 × 100.5.

The ARfD for chlorpyrifos was therefore calculated as follows:

1/(10 × 100.5) ≈ 0.03 mg/kg bw/day (30 µg/kg bw/day)

## Poison Scheduling

The Standard for the Uniform Scheduling of Medicines and Poisons (SUSMP) classifies chlorpyrifos as Schedule 6, with a cut-off to Schedule 5 when used in preparations at concentrations of 5% or less, when in aqueous preparations containing 20% or less of microencapsulated chlorpyrifos, or in controlled release granular formulations containing 10% or less of chlorpyrifos. Potting or soil mixes containing 100 g/m3 or less of chlorpyrifos are exempt from poisons scheduling.

There are no proposed changes to the poisoning scheduling of chlorpyrifos.

# Worker health and safety

## Previous assessments

In 2000, an [interim occupational health and safety (OHS) assessment](https://apvma.gov.au/node/14751) for chlorpyrifos was conducted by the Office of Chemical Safety within the Australian Government Department of Health (OCS) and an interim OHS report was published by the APVMA comprising exposure and risk assessments for chlorpyrifos (APVMA 2000d). A Margin of Exposure (MOE) approach was used that involved a calculation of the ratio between estimated exposure and a relevant NOAEL as established in the interim toxicology report. As an outcome of the assessment, several risk management outcomes were implemented.

The APVMA has substantially changed its approach to exposure assessment since the publication of its interim OHS assessment on chlorpyrifos in 2000. Further, as discussed in the [*Toxicology*](#_Toxicology) section, the human health-based guidance values for chlorpyrifos were lowered in 2019. This necessitated a re-evaluation of exposures and risk characterisations associated with the uses of chlorpyrifos.

In 2019, a [supplementary residential exposure assessment and risk characterisation report](https://apvma.gov.au/node/50121) was published by the APVMA (APVMA 2019b). The residential (non-professional) uses of chlorpyrifos were not supported due to concerns regarding uncontrolled human health risks associated with mixing, loading and applying chlorpyrifos and/or uncontrolled risks to children associated with re-entry into treated areas. Therefore, all home garden and domestic uses of chlorpyrifos were cancelled.

## Worker exposure assessment

The scope of this updated exposure assessment and risk characterisations includes professional workers who mix, load and apply chlorpyrifos and professional workers who re-enter chlorpyrifos treated areas or re-handle chlorpyrifos treated material (e.g. turf).

For exposure during mixing, loading and application, the current assessment has utilised the US EPA Office of Pesticide Programs Occupational Handler Exposure Calculator (US EPA 2020a). For exposure associated with re-entry into pesticide treated area, the current assessment has utilised the US EPA Occupational Pesticide Re-entry Exposure Calculator (US EPA 2020b).

The following assumptions have been used in the exposure modelling (see Table 7).

Table 7: Assumptions used in modelling exposure for professional use of chlorpyrifos

| Parameter | Value |
| --- | --- |
| Point of Departure for risk assessment | 0.1 mg/kg bw/day |
| Acceptable margin of exposure (MOE) | 100\* |
| Body weight (adult) | 80 kg |
| Body weight (child) | 1 to 2 y: 11 kg  2 to 3 y: 15 kg |
| Dermal absorption factor | 3% for concentrate and granule (0.03)  10% for spray dilution (0.1) |
| Inhalation absorption factor | 100% |
| Airblast foliar application (orchard/vineyard) | 30 ha/day |
| Groundboom field application (most crops) | 50 ha/day |
| Groundboom application to commercial turf farms | 30 ha/day |
| Groundboom field application (cotton) | 400 ha/day |
| Groundboom field application (broadacre uses) | 600 ha/day |
| Backpack application (mixer, loader, applicator) | 10x15L refills = 150 L/day |
| Manually pressurised hand wand application | 150 L/day |
| Mechanically pressurised handgun application | Strip or patch low on tree/vine (50–100 mL/tree) = 400 L/day  Spot treatment foliar = 1,000 L/day  Broadcast foliar = 4,000 L/day |

\* As a NOAEL from an animal study was used to estimate risks, an acceptable MOE ≥ 100 was considered acceptable. This value is based on a 10-fold uncertainty factor (UF) for intra-species and 10-fold UF for inter-species differences.

The exposure assessments and risk characterisations for professional use of chlorpyrifos also rely upon a further series of reasonable assumptions, notably that professional users:

* are trained in accurate mixing, loading and application methods
* are trained in, and are competent and experienced users of, personal protective equipment and relevant application techniques and equipment
* have a high level of compliance with label directions, including label-specified application rates and the use of personal protective equipment specified on product labels
* wear long-sleeved shirt, long pants, shoes and socks or an equivalent single layer of clothing when using chlorpyrifos, in addition to any personal protective equipment specified on product labels.

The exposure assessments and risk characterisations also assume that there are no concurrent co-exposures to other anticholinesterase products (the effects of which are likely to be at least additive to those of chlorpyrifos due to their common mode of action).

### Ground-based application

The outcomes for the exposure risk assessments for the professional use of chlorpyrifos in agricultural situations using ground-based application equipment are set out in Table 8 and Table 9. Modelling for ground-based application assumed that all steps in the use of chlorpyrifos products are performed by a single operator (i.e. a single operator mixes, loads and applies the pesticide) and that there was only one type of use or activity performed per operator per day. Modelling for re-entry activities (8-hour days) assessed worker exposure via dermal exposure, as inhalation exposure under these circumstances were regarded as negligible. It is noted that the calculated re-entry intervals are not required when crops are treated at the bare soil or pre-emergent stage.

Modelling for the use of a 100 g/kg granular product to be admixed with potting medium was undertaken using a reverse exposure approach. It was assumed that treating potting medium with the granular product could be achieved by mechanical means with very little operator exposure, e.g., if the potting medium and granular product were combined in a cement mixer-type vessel. Therefore, the calculation to determine the quantity of treated potting medium that could be handled in a single day was based on unit exposures for hand dispersal of a granular product and assumed that a high level of PPE was worn by individuals handling the treated potting medium (i.e., double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator). The label rate for that use is 50–100 g ac/m3 of potting medium. Using the above assumptions, a single operator would exceed acceptable risk levels from handling less than one cubic meter of treated potting medium.

The post-application exposure for turf treated in commercial turf farms was considered separately, and included potential exposure from transplanted turf, assuming that it would be harvested and laid in a variety of different situations (such as sports fields, rights of way and commercial or residential settings). Further modelling in turf was also performed to determine whether exposure to children from newly planted lawns using recently sprayed commercial turf would pose a significant post-application risk. It was concluded using highly conservative inputs that post-application exposure to adult workers handling treated turf was negligible when harvesting and re-planting on day one post chlorpyrifos treatment, and that the risks to children from newly planted lawns using recently sprayed commercial turf were acceptable.

Table 8: Chlorpyrifos uses that are supported based on this worker exposure assessment

| Crop | Rate | Application | Formulation Type1 | Mitigation for mixing/ loading and application (MOE ≥ 100) 2 | Re-entry interval |
| --- | --- | --- | --- | --- | --- |
| Fruit and vegetables | | | | | |
| Apples, pears | 250 g ac/ha | Airblast | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves.  EngC (A): Closed cab application equipment. | Dormant period: Not required. |
| 250 g ac/ha | Backpack | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Scouting – Day 7 |
| Avocado | 500 g ac/ha (25 g ac/100 L, spot spray) | Mechanically pressurised handgun | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Scouting, hand pruning – Day 8; Hand harvesting – Day 16 |
| Banana | One bag per bunch (0.45 g ac/bag) | Manual | SR | PPE (M/L&A): Elbow-length chemical resistant gloves, disposable fume mask with a charcoal filter | Not required |
| Beetroot, capsicum, carrots, green beans, peas, radishes, stalk and stem vegetables (asparagus, celery, rhubarb), turnips | 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Irrigation (hand set) – Day 13; Hand harvesting – Day 7 |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16; Hand harvesting – Day 11 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 17; Hand harvesting – Day 12. |
| Cassava | 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16; Hand harvesting – Day 11 |
| Citrus fruit, pome fruit | 250 g ac/ha | Airblast | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves  EngC (A): Closed cab application equipment | Scouting, hand pruning, training – Day 1; Hand harvesting – Day 10; Thinning fruit – Day 19 |
| Cole crops (brassica crops) | 150 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Scouting, hand harvesting, hand weeding – Day 15; Irrigation (hand set) – Day 8; Hand weeding (smaller plants) – Day 5 |
| 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Scouting, hand harvesting, hand weeding – Day 20; Irrigation (hand set) – Day 13; Hand weeding (smaller plants) – Day 10 |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator.  EngC (A): Closed cab application equipment. | Scouting, hand harvesting, hand weeding – Day 23; Irrigation (hand set) – Day 16; Hand weeding (smaller plants) – Day 13 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Scouting, hand harvesting, hand weeding – Day 25; Irrigation (hand set) – Day 17; Hand weeding (smaller plants) – Day 14 |
| 450 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Scouting, hand harvesting, hand weeding – Day 26; Irrigation (hand set) – Day 18; Hand weeding (smaller plants) – Day 15; Scouting, thinning (smaller plants) – Day 1. |
| Cucurbit vegetables | 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Irrigation (hand set) – Day 13; Harvesting, training and turning – Day 1 |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16; Harvesting, training and turning – Day 4 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (handset) – Day 17; Harvesting, and training and turning – Day 5 |
| Eggplant | 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Irrigation (hand set) – Day 13; Hand harvesting – Day 1 |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16; Hand harvesting – Day 4 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 17; Hand harvesting – Day 5 |
| Ginger | 450 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 18 |
| WP | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves and full facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 18 |
| Grapes (grape vines) | 250 g ac/ha | Airblast | EC WG  WP | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves  EngC (A): Closed cab application equipment | Dormant period: Not required  Seasonal period (not practical): Girdling – > 30 days; Tying AND training, leaf pulling, harvesting, – Day 28; Irrigation (hand set) – Day 13; Scouting, hand weeding, hand pruning, bird control, propagating, trellis repair – Day 3 |
| Leafy crucifers (including chou moullier, kale, mustard, rape), lettuce, silver beet) | 150 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Irrigation (hand set) – Day 8; Hand harvesting – Day 2. |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 17; Hand harvesting – Day 12. |
| Macrocarpa hedges | 250 g ac/ha | Airblast | WP WG | PPE (M/L): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 13; Scouting, shaping – Day 1. |
| Onions, shallots | 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Hand weeding (full foliage) – Day 20; Irrigation (hand set) – Day 13; Hand weeding (minimal foliage), scouting – Day 10 |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Hand weeding (full foliage) – Day 23; Irrigation (hand set) – Day 16; Hand weeding (minimal foliage), scouting – Day 13 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Hand weeding (full foliage) – Day 25; Irrigation (hand set) – Day 17; Hand weeding (minimal foliage), scouting – Day 14 |
| Parsnip | 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Day 17 – Irrigation (hand set); Day 12 – Hand harvesting |
| Potato, sweet potato | 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Irrigation (hand set) – Day 13. |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 17 |
| Swede, turnip | 150 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Irrigation (hand set) – Day 8; Hand harvesting – Day 2 |
| Stone fruits | 250 g ac/ha | Airblast | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves  EngC (A): Closed cab application equipment | Dormant period: Not required |
| 0.0125– 0.025 g ac/tree | Mechanically pressurised handgun application (strip or patch low on tree/vine) | WG | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not required |
| Tomatoes | 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Irrigation (hand set) – Day 13; Hand harvesting, tying and training – Day 7 |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16; Hand harvesting, tying and training – Day 11 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 17; Hand harvesting, tying and training – Day 12 |
| Field crops and pasture | | | | | |
| Barley, canola (rapeseed), wheat5 | 200 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Scouting – Day 5 |
| 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Scouting – Day 12 |
| Canola (rapeseed), cereals5 | 35 g ac/ha, 70 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Not required |
| Cereals (including sorghum) 5 | 150 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Scouting – Day 2; Scouting (sorghum) – not required |
| 175 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Scouting – Day 4; Scouting (sorghum) – not required |
| 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Scouting – Day 7; Scouting (sorghum) – not required |
| 280 g ac/ha | Groundboom | EC | PPE (M/L): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves  EngC (A): Closed cab application equipment | Scouting – Day 8; Scouting (sorghum) – not required |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Scouting – Day 11; Scouting (sorghum) – not required |
| Field peas, broad beans (faba beans), chickpeas, lupins5 | 150 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Irrigation (hand set) – Day 8; Scouting – Day 2 |
| Field peas, lupins5 | 200 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Irrigation (hand set) – Day 10; Scouting – Day 5 |
| Lucerne, lucerne seed crops, subterranean clover, clover | 200 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Irrigation (hand set) – Day 10; Scouting – Day 5 |
| Lucerne, subterranean clover, clover | 400 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 17; Scouting – Day 12 |
| Pasture and forage crops | 35 g ac/ha, 70 g ac/ha | Groundboom | EC | PPE: Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Not required |
| 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator 3 | Irrigation (hand set) – Day 13; Scouting – Day 7 |
| 280 g ac/ha | Groundboom | EC | PPE (M/L): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 14; Scouting – Day 8 |
| Pasture and forage crops, lucerne, lucerne seed crops | 175 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Irrigation (hand set) – Day 9; Scouting – Day 4 |
| 350 g ac/ha | Groundboom | EC | PE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16; Scouting – Day 11 |
| Pasture and forage crops, lucerne, lucerne seed crops, clover seed crops, medics | 150 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Irrigation (hand set) – Day 8; Scouting – Day 2 |
| Oilseeds (excluding cotton)6 | 150 g ac/ha | Groundboom | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Irrigation (hand set) – Day 8; Scouting – Day 2; Scouting (peanut and sunflower) – not required |
| 250 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Irrigation (hand set) – Day 13; Scouting – Day 7; Scouting (peanut and sunflower) – not required |
| 350 g ac/ha | Groundboom | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Irrigation (hand set) – Day 16 (forage crop only); Scouting – Day 11; Scouting (peanut and sunflower) – not required |
| Rice | 35 g ac/ha, 70 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not required |
| Sugarcane | 175 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Day 4 – Scouting |
| 350 g ac/ha | Groundboom | EC | PE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator  EngC (A): Closed cab application equipment | Day 11 – Scouting |
| Miscellaneous uses | | | | | |
| Agricultural, commercial and industrial areas (not publicly accessible) | 4.5 g ac/L water to 5 g ac/L water (outdoor use) | Manually pressurised handwand | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves, half facepiece respirator | Not applicable |
| Container plants (commercial cultivation) | 5 g ac/L water | Manually pressurised handwand | WG WP | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not applicable |
| Hides/skins | 1 g ac/L water | Manually pressurised handwand | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Not applicable |
| Potted ornamentals (commercial cultivation) | 0.1–0.2 g ac/L water | Manually pressurised handwand | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Not applicable |
| Termiticide – chemical soil barrier around buildings (reticulated or AS Series 3660 systems) | 50 g ac/m2 | Mechanically pressurised handgun | EC | PPE (M/L): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not applicable |
| Termiticide – nest or colony | 5 g ac/L water | Manually pressurized handwand (spot spray) | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not applicable |
| Turf(commercial turf that is not publicly accessible) | 1,000 g ac/ha | Rotary spreader | GR | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves. | Not required |
| 0.015 g ac/mound | Backpack (spot spray) | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Not required |
| 10 g ac/20 L water/ha 4 | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not required |
| 350 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not required |
| 450 g ac/ha | Groundboom | EC | PPE (M/L&A): Chemical resistant clothing, elbow-length chemical resistant gloves, half facepiece respirator | Not required |
| Vegetation (not publicly accessible) | 14 g ac/ha to 54 g ac/ha | Manually pressurized handwand | EC | PPE (M/L&A): Cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves | Not applicable |
| Veterinary uses | | | | | |
| Ear tags of beef cattle | 1.5 g ac/tag 1 tag/animal | Ear tag | Ear tag | PPE (A): rubber gloves. Occupational handler exposure considered negligible | Not applicable |

1 EC = emulsifiable concentrate; SR = slow-release generator; WG = water dispersible granule; WP = wettable powder

2 PPE = personal protective equipment; M/L = mixing/loading; A = application; EngC = engineering controls

3 Use patterns would also be supported with use of cotton overalls, buttoned to the neck and wrist (or equivalent clothing), chemical resistant gloves for mixing/loading and use of closed cab application equipment.

4 Product labels are inconsistent with the application rate. Some specify this as a per hectare rate, others only specify the concentration. MOE was calculated based on this being a per hectare rate, using groundboom application equipment.

5 Use not considered practical with the required work rate restriction of 50 ha/day.

6 For application rates at 70 g ac/ha to 110 g ac/ha, the maximum work rate that does not exceed acceptable risks to applicators occupational handlers (mixing, loading and application) is 125 ha/day.

Table 9: Chlorpyrifos uses that are not supported based on this worker exposure assessment

| Crop | Rate | Application | Formulation Type 1 | Mixing, loading, application outcome |
| --- | --- | --- | --- | --- |
| Fruit and vegetables | | | | |
| Apples, avocado, banana, pears, stone fruits | 1,000 g ac/ha | Airblast | EC WP | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Apples, banana, grapes (grape vines), kiwifruit, pears, stone fruits | 500 g ac/ha | Airblast | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| 500 g ac/ha | Airblast | WG WP | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Avocado | 500 – 1,000 g ac/ha + 500 g ac/ha dichlorvos | Airblast | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 1,000 g ac/ha | Mechanically pressurised handgun application (spot spray) | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| Banana | 500 to 900 g ac/100 L water or 2.5 to 3.5 g ac/stool | Mechanically pressurised handgun application | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| 250 g ac/100 L water | Mechanically pressurised handgun application | WG WP | MOE < 100 with maximum PPE for mixing/loading and application |
| 250 g ac/4 kg sand | Hand dispersal | WG WP | MOE < 100 with maximum PPE for mixing/loading and application |
| 75–100 g ac/ha | Mechanically pressurised handgun application (spot spray) | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| 5 g ac/5 L | Backpack | WP | MOE < 100 with maximum PPE for mixing/loading and application |
| Beetroot, carrot, cereals, onions, radish, shallots and turnips | 250 g ac/ha/10 kg seed | Seed treatment | WP | MOE < 100 with maximum PPE for mixing/loading and application |
| Cabbage, cauliflower | 1,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 150 g ac/100 L water | Mechanically pressurised handgun application (soil drench) | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| Citrus fruits | 1,000–2,000 g ac/ha | Airblast | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 1,000 g ac/100 L water | Airblast | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Custard apple | 1,000–10,000 g ac/ha | Airblast | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Mango | 1,000 g ac/ha, 2,000 g ac/ha | Airblast | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Pineapple | 750 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| 1,500 g ac/ha, 2,500 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Potatoes | 1,500 g ac/ha– 3,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Strawberries, vegetables (various) | 50 g ac/ha | Broadcast bait application | EC | Inadequate information included on product labels to assess exposure from mixing, loading and application |
| Tomatoes | 2,500 g ac/ha, 1,500 g ac/ha,  1,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 750 g ac/ha,  500 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| Various (Queensland fruit fly control) | 0.1–0.2 g ac/tree or 30–60 g ac/ha | Mechanically pressurised handgun application (strip or patch low on tree/vine) | EC WG WP | MOE < 100 with maximum PPE for mixing/loading and application |
| Vegetables (various) | 1,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 500–750 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| Field crops and pasture | | | | |
| Cereals | 250 g ac/125 kg seed, 125–250 g ac/210 kg seed, 40–60 g ac/100 kg seed | Seed treatment | WP | MOE < 100 with maximum PPE for mixing/loading and application |
| Cereals, pastures and forage crops | 150–350 g ac/ha | Mister | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Cereals, oilseeds (including canola), pastures and forage crops, sorghum | 450–750 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| Cereals, oilseeds | 125 g/310 kg seed | Seed treatment | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| Coffee beans | 1,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Cotton | 70–1,500 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Cotton, lucerne, maize, pulses, sorghum, sunflower | 50 g ac/ha | Broadcast bait application | EC | Inadequate information included on product labels to assess exposure from mixing, loading and application |
| Cotton, lucerne, maize, sorghum, sunflower | 100 g ac/ha | Broadcast bait application | EC | Inadequate information included on product labels to assess exposure from mixing, loading and application |
| Field crops (broadacre use, various including cereals, canola and pulses) | ≥ 35 g ac/ha | Groundboom (broadacre use) | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Hops | 800 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Maize | 1,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Maize, safflower, sunflower | 750 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| Rice | 750 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| Tobacco | 1500 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| Sugarcane | 1,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 450–750 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| Miscellaneous uses | | | | |
| Agricultural, commercial and industrial areas (not publicly accessible) | 4.5 g ac/L water to 5 g ac/L water | Backpack or mechanically pressurised handgun | EC | MOE < 100 with maximum PPE for mixing/loading and application |
|  | 2.5 g ac/L water to 5 g ac/L water (indoor use) | Manually pressurized handwand | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| Commercial and industrial areas (not publicly accessible) | 1 g ac/10 m2 | Hand dispersal | GR | MOE < 100 with maximum PPE for loading and application |
| Duboisia | 450 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| Grapevine rootlings | 8000 g ac/ha | Hand dispersal | GR | MOE < 100 with maximum PPE for loading and application |
| Ornamental nursery plants | 250 to 500 g ac/m3 potting medium | Hand dispersal | GR | Not practical due to restricted volume of potting-medium that may be handled while maintaining acceptable risks to applicators (<1 cubic meter) |
| Outdoor areas (not publicly accessible) | 1 g ac/10 m2 | Hand dispersal | GR | MOE < 100 with maximum PPE for loading and application |
| Polluted water impoundments | 1 g ac/10,000 L water or 10 g ac/100 m3 | Backpack or mechanically pressurized handgun | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| Tasmanian blue gum | 1,500 g ac/ha | Hand dispersal | GR | MOE < 100 with maximum PPE for loading and application |
| Termiticide – chemical soil barrier around and under buildings | 50 g ac/m2 or 100 g ac/m2 (horizontal barrier) | Soil injection or mechanically pressurized handgun | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| 1000 g ac/m3 or 2000 g ac/m3 (vertical barrier) | Soil injection or mechanically pressurized handgun | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| Termiticide – chemical soil barrier around poles | 10 g ac/L water | Soil injection or mechanically pressurized handgun | EC | MOE < 100 with maximum PPE for mixing/loading and application |
| Turf (commercial turf that is not publicly accessible) | 2,000 g ac/ha, 3,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 2,000 g ac/ha | Rotary spreader | GR | MOE < 100 with maximum PPE for loading and application |
| 1,000 g ac/ha | Hand dispersal | GR | MOE < 100 with maximum PPE for loading and application |
| 1,000 g ac/ha | Groundboom | EC | MOE < 100 with maximum PPE for mixing/loading and closed cab application 2 |
| 350 g ac/ha | Mister | EC | MOE < 100 with maximum PPE (or engineering controls) for mixing/loading and closed cab application |
| 12.5 g ac/ha, 50 g ac/ha | Broadcast bait application | EC | Inadequate information included on product labels to assess exposure from mixing, loading and application |
| Vegetation (not publicly accessible) | 13–54 g ac/ha | Backpack or mechanically pressurized handgun | EC | MOE < 100 with maximum PPE for mixing/loading and application |

1 Maximum PPE for EC products: Double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator. Maximum PPE for GR/WP/WG products: Double layer of clothing, elbow-length chemical resistant gloves and a full facepiece respirator.

2 Operator exposure may be minimized during mixing and loading by using engineering controls (i.e. addition of sealed, lockable valves resulting in closed transfer of the product from its packaging to the spray tank). The APVMA does not have sufficient evidence that use of these mixing/loading engineering controls could be feasibly implemented and managed.

### Aerial application

Modelling for aerial application was undertaken using a reverse exposure approach. That is, for both the pilot and the mixer/loader, a calculation was undertaken to determine the quantity of product that could be applied (pilot) or handled during mixing/loading activities. For this reverse exposure assessment, it has been assumed that mixing and loading activities are performed by someone other than the pilot. As unit exposures differ for liquids and granular products, Table 10 presents the maximum quantities that can be handled with corresponding maximum areas treated based on representative use rates.

Table 10: Aerial application maximum acceptable quantities of chlorpyrifos handled/applied per day for mixer/loader activities and applicators (aerial fixed wing pilots)

| Activity | Maximum quantity per day (liquid) | Maximum quantity per day (granule) | Representative application rate | Maximum area treated per day (liquid) | Maximum area treated per day (granule) |
| --- | --- | --- | --- | --- | --- |
| Pilot | 168 kg | 51.8 kg | 150 g ac/ha | 1120 ha | 345 ha |
| 350 g ac/ha | 480 ha | 148 ha |
| 500 g ac/ha | 336 ha | 103 ha |
| 750 g ac/ha | 224 ha | 69 ha |
| Mixer/loader1 | 26.7 kg | 33.6 kg | 150 g ac/ha | 178 ha | 224 ha |
| 350 g ac/ha | 76 ha | 96 ha |
| 500 g ac/ha | 53 ha | 67 ha |
| 750 g ac/ha | 35 ha | 44 ha |
| Mixer/loader2 | 40 kg | 139 kg | 150 g ac/ha | 266 ha | 926 ha |
| 350 g ac/ha | 114 ha | 397 ha |
| 500 g ac/ha | 80 ha | 278 ha |
| 750 g ac/ha | 53 ha | 185 ha |

1 Baseline PPE: Single layer of clothing and elbow-length chemical resistant gloves

2 Baseline PPE: Double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator

It is considered that aerial application of products containing chlorpyrifos would not be practical due to the restricted areas that may be treated while maintaining acceptable risks to the mixers/loaders and applicators. Even with the lowest application rates on representative product labels, the mixing and loading tasks may need to be divided by multiple individuals to possibly be considered suitable for application by aerial methods. It should also be noted that pilot exposure to granular formulations is higher than a mixer/loader wearing a double layer of clothing, elbow-length chemical resistant gloves and a half facepiece respirator. The following restraint is therefore advised for all products containing chlorpyrifos:

DO NOT apply by aircraft.

### Para-occupational exposure

The potential for para-occupational (or ‘take-home’) exposure to chlorpyrifos is considered negligible based on US data that that maximum concentration of chlorpyrifos in farmworker homes is 200 ng/g (Quirós-Alcalá et al. 2011), an assumed default bioavailability of 0.1, dust ingestion of 60 mg for adults and 100 mg for toddlers (based on the 95th percentile values in the Australian Exposure Factors Guide), and the ADI of 1,000 ng/kg bw/d (0.001 mg/kg bw/d). Further, good worker hygiene practices are expected for product users, re-entry workers and workers re-handling treated commodities/turf. Therefore, the para-occupational risks associated with use of chlorpyrifos-containing products, in accordance with label directions, is considered to be low.

## First aid instructions and warning statements

The revised the first aid instructions (FAI) and warning statements for chlorpyrifos products whose uses are supported are listed in Table 11 and should be included in the relevant product labels.

Table 11: Chlorpyrifos first aid instructions and warning statements

| Status | Substance | Concentration | First aid instruction | Warning statement |
| --- | --- | --- | --- | --- |
| Existing entry | Chlorpyrifos | ≤ 5% | a | Nil |
| Existing entry | Liquid hydrocarbons | > 25% | a, c | Nil |
| Amended entry | Chlorpyrifos | > 5% | a, m, s | 31, 53 |
| Amended entry | Chlorpyrifos (slow-release impregnated plastics) | Any | a | Nil |

### First aid instructions

First Aid instructions a, c, m and s should appear on labels for products that contain chlorpyrifos (over 5%) and liquid hydrocarbon (over 25%), as:

* If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126.
* If swallowed, do NOT induce vomiting.
* If swallowed, splashed on skin or in eyes, or inhaled, contact a Poisons Information Centre (Phone Australia 131126) or a doctor at once. Remove any contaminated clothing and wash skin thoroughly. Give atropine if instructed.
* If in eyes, hold eyes open, flood with water for at least 15 minutes and see a doctor.

First Aid instructions a, m and s should appear on labels for products that contain chlorpyrifos (over 5%), as:

* If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126.
* If swallowed, splashed on skin or in eyes, or inhaled, contact a Poisons Information Centre (Phone Australia 131126) or a doctor at once. Remove any contaminated clothing and wash skin thoroughly. Give atropine if instructed.
* If in eyes, hold eyes open, flood with water for at least 15 minutes and see a doctor.

First Aid instruction a should appear on labels for products that contain chlorpyrifos (less than or equal to 5% or products formulated as a slow-release impregnated plastic), as:

* If poisoning occurs, contact a doctor or Poisons Information Centre. Phone Australia 131126.

### Warning statements

The following warning statements should be added to the FAI entry – chlorpyrifos > 5% in the FAISD Handbook, excluding when formulated as a slow-release impregnated plastic.

* 31 – Breathing vapour or spray mist is harmful and may cause an asthma-like reaction
* 53 – WARNING – Contains (name of substance), excessive exposure to which may temporarily interfere with vision and the ability to safely operate machinery.

## Safety directions

The revised the safety directions for chlorpyrifos products, based on the uses supported by the APVMA review, are listed in Table 12 to Table 17. The updated safety directions given below should be included in product labels.

### 

### Chlorpyrifos ear tag 100 g/kg (or less)

Table 12: Safety directions for chlorpyrifos ear tag 100 g/kg (or less)

| Substance | Formulation | Statement codes |
| --- | --- | --- |
| Diazinon | Ear tag 300 g/kg with chlorpyrifos 100 g/kg or less | 130 133 190 160 162 210 211 380 382 279 283 290 312 350 360 361 |

The above statement codes translate into the following safety directions:

| Safety directions | Code |
| --- | --- |
| Hazards | |
| Poisonous if swallowed | 130 133 |
| Repeated minor exposure may have a cumulative poisoning effect | 190 |
| May irritate the eyes | 160 162 |
| Precautions | |
| Avoid contact with eyes and skin | 210 211 |
| Do not open inner pouch until ready for use | 380 |
| Do not allow children to play with tags | 382 |
| Mixing or using | |
| When using the product, wear rubber gloves | 279 283 290 312 |
| After use | |
| After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water. | 350 |
| After each day’s use wash gloves. | 360 361 |

### Chlorpyrifos SR impregnated plastic film 10 kg (or less)

Table 13: Safety directions for chlorpyrifos SR impregnated plastic film 10 kg (or less)

| Substance | Formulation | Statement codes |
| --- | --- | --- |
| Chlorpyrifos | SR impregnated plastic film 10 g/kg or less | 130 133 190 160 162 210 211 382 279 283 290 295 306 351 360 361 |

The above statement codes translate into the following safety directions:

| Safety Directions | Code |
| --- | --- |
| Hazards | |
| Poisonous if swallowed | 130 133 |
| Repeated minor exposure may have a cumulative poisoning effect | 190 |
| May irritate the eyes | 160 162 |
| Precautions | |
| Avoid contact with eyes and skin | 210 211 |
| Do not allow children to play with bags | 382 |
| Mixing or using | |
| When using the product, wear elbow-length PVC or nitrile gloves and a disposable fume mask with charcoal filter. | 279 283 290 295 306 |
| After use | |
| Wash hands after use. | 351 |
| After each day’s use wash gloves. | 360 361 |

### Chlorpyrifos EC 500 g/L (or less)

Table 14: Safety directions for chlorpyrifos EC 500 g/L (or less)

| Substance | Formulation | Statement Codes |
| --- | --- | --- |
| Chlorpyrifos | EC 500 g/L or less in liquid hydrocarbon 520 g/L or less | 120 130 131 132 133 180 190 161 162 164 210 211 220 222 223 279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343 350 360 361 364 365 366 |

The above statement codes translate into the following safety directions:

| Safety directions | Code |
| --- | --- |
| Hazards | |
| Product is poisonous if absorbed by skin contact, inhaled or swallowed | 120 130 131 132 133 |
| Repeated exposure may cause allergic disorders | 180 |
| Repeated minor exposure may have a cumulative poisoning effect | 190 |
| Will irritate eyes and skin | 161 162 164 |
| Precautions | |
| Avoid contact with eyes and skin | 210 211 |
| Do not inhale vapour or spray mist | 220 222 223 |
| Mixing or using | |
| When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length chemical resistant gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge. If clothing becomes contaminated with product or wet with spray, remove clothing immediately. If product on skin, immediately wash area with soap and water. If product in eyes, wash it out immediately with water. | 279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343 |
| After use | |
| After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water. | 350 |
| After each day’s use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing. | 360 361 364 365 366 |

### Chlorpyrifos EC 700 g/L (or less)

Table 15: Safety directions for chlorpyrifos EC 700 g/L (or less)

| Substance | Formulation | Statement codes |
| --- | --- | --- |
| Chlorpyrifos | EC 700 g/L or less in phenyl methyl ketone 500 g/L or less | 120 130 131 132 133 190 161 162 164 210 211 220 222 223 279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343 350 360 361 364 365 366 |

The above statement codes translate into the following safety directions:

| Safety directions | Code |
| --- | --- |
| Hazards | |
| Product is poisonous if absorbed by skin contact, inhaled or swallowed | 120 130 131 132 133 |
| Repeated minor exposure may have a cumulative poisoning effect | 190 |
| Will irritate eyes and skin | 161 162 164 |
| Precautions | |
| Avoid contact with eyes and skin | 210 211 |
| Do not inhale vapour or spray mist | 220 222 223 |
| Mixing or using | |
| When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length chemical resistant gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge. If clothing becomes contaminated with product or wet with spray, remove clothing immediately. If product on skin, immediately wash area with soap and water. If product in eyes, wash it out immediately with water. | 279 280 281 282 290 291b 294c 299 298a 300 303 330 331 332 340 342 340 343 |
| After use | |
| After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water. | 350 |
| After each day’s use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing. | 360 361 364 365 366 |

### Chlorpyrifos WP 500 g/kg (or less)

Table 16: Safety directions for chlorpyrifos WP 500 g/kg (or less)

| Substance | Formulation | Statement codes |
| --- | --- | --- |
| Chlorpyrifos | WP 500 g/kg or less | 120 130 131 132 133 190 161 162 164 210 211 220 221 223 279 280 281 282 290 291b 294c 299 298a 300 303 350 360 361 363 364 366 |

The above statement codes translate into the following safety directions:

| Safety directions | Code |
| --- | --- |
| Hazards | |
| Product is poisonous if absorbed by skin contact, inhaled or swallowed | 120 130 131 132 133 |
| Repeated minor exposure may have a cumulative poisoning effect | 190 |
| Will irritate eyes and skin | 161 162 164 |
| Precautions | |
| Avoid contact with eyes and skin | 210 211 |
| Do not inhale vapour or spray mist | 220 221 223 |
| Mixing or using | |
| When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length chemical resistant gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge. | 279 280 281 282 290 291b 294c 299 298a 300 303 |
| After use | |
| After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water. | 350 |
| After each day’s use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing. | 360 361 364 365 366 |

### Chlorpyrifos WG 750 g/kg (or less)

Table 17: Safety directions for chlorpyrifos WG 750 g/kg (or less)

| Substance | Formulation | Statement codes |
| --- | --- | --- |
| Chlorpyrifos | WG 750 g/kg or less | 129 133 190 161 162 210 162 279 280 281 282 290 291b 294 299 298a 300 303 350 360 361 365 364 366 |

The above statement codes translate into the following safety directions:

| Safety directions | Code |
| --- | --- |
| Hazards | |
| Harmful if swallowed | 129 133 |
| Repeated minor exposure may have a cumulative poisoning effect | 190 |
| Will irritate eyes | 161 162 |
| Precautions | |
| Avoid contact with eyes | 210 162 |
| Mixing or using | |
| When opening the container, preparing the spray and using the prepared spray, wear chemical resistant clothing buttoned to the neck and wrist, a washable hat, elbow-length PVC gloves, face shield or goggles, chemical resistant footwear and a half facepiece respirator with combined dust and gas cartridge. | 279 280 281 282 290 291b 294 299 298a 300 303 |
| After use | |
| After use and before eating, drinking or smoking, wash hands, arms and face thoroughly with soap and water. | 350 |
| After each day’s use wash gloves, face shield or goggles, respirator (if rubber wash with detergent and warm water) and contaminated clothing. | 360 361 365 364 366 |

## Worker health and safety recommendations

The following uses of chlorpyrifos are not supported based on potential risks identified in the worker health and safety assessment:

* Aerial application to all crops
* Airblast application to fruits and vegetables at rates that exceed 250 g ac/ha
* Groundboom application to cotton crops
* Broadacre groundboom application to all field crops
* Groundboom application to vegetables, field crops and duboisia at rates that exceed 400 g ac/ha
* Mister application to cereals, pastures and forage crops
* Mechanically pressurised handgun application to avocado crops at rates that exceed 500 g ac/ha and for the control of Queensland fruit fly in various crops
* Backpack or mechanically pressurised handgun application to agricultural, commercial and industrial areas, polluted water impounds and vegetation
* Manually pressurised handwand application to indoor agricultural, commercial and industrial areas
* Soil injection or mechanically pressurized handgun application for termiticide chemical soil barriers around and under buildings (excluding use of reticulated or AS Series 3660 systems) and around poles
* Application to bananas (except when product is formulated as a slow-release generator)
* Application to turf at, or exceeding, a rate of 1,000 g ac/ha
* Application of granular formulated products
* Seed dressings
* Insect baits

While a number of chlorpyrifos use patterns could be supported from a worker health and safety perspective (see Table 8), many of these uses were not supported in the contemporary residues and trade assessments and environment assessments. The first aid instructions, warning statements and safety directions recommended in this report are reflective of uses supported by all assessment areas. The relevant first aid instructions and warning statement listed in Table 11 and the relevant safety directions listed in Table 12 to Table 17 should be included on all product labels.

The following restraints should also be included on all labels (excluding where use of this application equipment would not be relevant, such as products formulated as slow-release generators or ear tags) to mitigate the identified potential risks to product users:

* DO NOT apply using equipment carried on the back of the user.
* DO NOT apply using mechanically pressurized hand wand sprayer.

# Residues and trade

## Previous assessments

In 2000, an [interim agricultural assessment for chlorpyrifos](https://apvma.gov.au/node/14741) was published by the APVMA, which included a residues and trade assessment (APVMA 2000a). The 2000 interim review report found that additional residues data were required to affirm proposed MRL recommendations for Australian food and animal feed commodities. As a result, several risk management measures were implemented including amendments to label information including establishment of withholding periods (WHPs) and amendment of MRLs including the establishment of temporary MRLs pending the submission of further data.

In 2009, the APVMA published a [Preliminary Review Findings (PRF)](https://apvma.gov.au/node/14761) report (APVMA 2009). The additional residues data were assessed in this report and formed the basis of recommendations, including amendments to WHPs and certain use patterns, addition of export intervals, cancellation of certain crops and use patterns, and amendments to the APVMA MRL standard (Tables 1 and 4) for chlorpyrifos.

As discussed in the [*Toxicology*](#_Toxicology) section, the human health-based guidance values for chlorpyrifos were lowered in 2019. This necessitated a re-evaluation of the consumer safety assessment considering these revised health-based guidance values. Further, since the 2009 PRF consultation, many international MRLs for chlorpyrifos have been reduced or removed. Codex and the USA have revoked all MRLs for chlorpyrifos while the European Union have replaced previously established chlorpyrifos MRLs with a default value at \*0.01 mg/kg where the ‘\*’ denotes that the MRL is set at or about the limit of analytical quantitation. Due to the changes in international MRLs for chlorpyrifos, a contemporary trade risk assessment is also warranted.

## Residues in food and animal feeds

A summary of the residues assessment outcomes for various crop groupings are shown in Table 18 and Table 19. No additional data was received in the 2009 PRF public consultation, though comments received in relation to some crops have been considered. This included requests to consider support for some chlorpyrifos uses in brassica vegetables, bulb vegetables, custard apple, lettuce, oilseeds, root and tuber vegetables, and tomatoes, where some uses are now supported with clarified withholding periods, application timing restrictions or other critical comments (see Table 18 and Table 19).

The approved uses of chlorpyrifos on shallots (equivalent directions to use on onions) and coffee beans have also been considered, as these use patterns were not directly considered in the 2009 PRF report. It was confirmed that the chlorpyrifos uses on cucumber could not be extended into all cucurbits, as residue data addressing the 7-day WHP is only available for cucumber. Similarly, residues data for asparagus and celery could not be extrapolated to other members of the stalk and stem vegetables, except rhubarb, as artichoke globe is a representative crop for this crop group and data for that crop is not available. Consideration of potential extension of uses beyond those uses that are currently on chlorpyrifos product labels are out of scope for this residues assessment.

The contemporary assessment of worker health and safety, environment and/or trade risk has not supported the use of chlorpyrifos in food-producing situations with the exception of the use of banana bags, a specific use on oilseeds (except canola and cotton) made prior to emergence at a maximum rate of 110 g ac/ha, and cattle ear tags.

For bananas, there is sufficient residues data to support the banana bag use. in 2 trials reflecting the current banana bag use (one bag per bunch), chlorpyrifos residues in whole banana fruit were <0.05 and 0.08 mg/kg at the 10-week harvest withholding period and a chlorpyrifos MRL for bananas at 0.2 mg/kg is considered appropriate for this use pattern (Farnsworth 2001; Farnsworth 2001a). In one trial where residues were determined separately in skin and pulp, chlorpyrifos residues were detected only in the banana skin and residues were <0.05 mg/kg in the pulp of the fruit.

For oilseeds (except canola and cotton), the specific use pattern that could be supported from an environmental and worker health and safety perspective involves a single application made prior to emergence at a maximum rate of 110 g ac/ha. Residues data which addresses that specific use pattern is not available. Residue trials for oilseeds that address all relevant food and feed commodities (seed, forage and fodder) involve foliar application at 675 g ai/ha, and these trials are summarised in the 2009 PRF. The data indicates that chlorpyrifos residues should be <0.01 mg/kg in seed from this specific use pattern, but that finite residues may be expected in oilseed forage and fodder.

Should it be approved, this specific use on oilseeds (except canola and cotton) would be the only use resulting in chlorpyrifos residues in animal feeds and as it will be driving the maximum feeding level and MRLs required for mammalian animal commodities, it is important that the APVMA have confidence in the level of residues expected in forage and fodder from that use pattern. The rate associated with this specific use pattern (110 g ac/ha) is 0.16× that addressed in the forage and fodder residue trials and [OECD guidance](https://one.oecd.org/document/ENV/JM/MONO(2011)50/REV1/en/pdf) for crop field trials indicates that the proportionality concept can only be applied to data from field trials conducted within a rate range of between 0.3× and 4× the rate. The fact that the trials involved foliar applications to actively growing crops is another difference to the supported pre-emergent use pattern. It is therefore considered that proportionality cannot be applied to estimate residues expected from this specific use pattern from the available dataset with confidence.

Due to the difference in the use pattern addressed in the residue trials, with the use pattern that can be supported from an environmental and worker health and safety perspective, it is concluded that there is insufficient data for a robust assessment of the level of chlorpyrifos residues expected in oilseed forage and fodder. Therefore, this specific use on oilseeds (except canola and cotton) cannot be supported at this time from a Residues and Trade perspective.

Table 18: Summary of residue assessment outcomes for horticultural crops

| Parameter | Assessment outcome |
| --- | --- |
| Avocado | |
| Uses supported by Residues | Leafrollers, hairy caterpillar, scales, light brown apple moth, red shouldered leaf beetle and Queensland fruit fly |
| Uses not supported by Residues | None |
| MRL1 | 0.5 mg/ka |
| WHP | 7 days |
| Other label statement/restriction | Nil |
| Banana | |
| Uses supported by Residues | Bell treatment, foliar treatment, soil/butt treatment, bag dust and treated banana bag |
| Uses not supported by Residues | Any treatment after the exposure of fingers |
| MRL1 | 0.5 mg/kg |
| MRL (based on use patterns for banana bags only) | 0.2 mg/kg |
| WHP | Not required when used as directed, or 10 weeks for the banana bag product. |
| Other label statement/restriction | For bell treatment, foliar treatment, soil/butt treatment and bag dust: DO NOT apply after the exposure of fingers |
| Brassica vegetables | |
| Uses supported by Residues | Mites, cutworms, crickets (bran baits), vegetable weevil, African black beetle, wingless grasshopper |
| Uses not supported by Residues | Butterflies, moths, caterpillars, aphids, budworm and corn earworm |
| MRL1 | 0.05 mg/kg |
| WHP | Not required when used as directed |
| Other label statement/restriction | Critical comments for African black beetle2, cutworms, mites and vegetable weevil and wingless grasshoppers2 (application rate up to 450 g ac/ha) – DO NOT apply after 14 days of transplanting.  Critical comments for African black beetle (cabbage and cauliflower application rate 1 kg ac/ha) – Restrict to single application within 7 days of transplanting.  To align with the nomenclature of Codex commodity classification and APVMA crop group guidance, the term ‘cole vegetables’ should be changed to ‘Brassica vegetables’ on product labels. |
| Bulb vegetables (onions and shallots) | |
| Uses supported by Residues | Bulb onion and shallot: Cutworms, crickets (bran baits), wingless grasshopper and vegetable weevil; Bulb onion only: Seed dressing uses – cutworms, earwigs, false wireworms, field crickets, harvester ants and mole crickets. |
| Uses not supported by Residues | None |
| MRL1 | 0.05 mg/kg (bulb onion and shallot) |
| WHP | Not required when used as directed |
| Other label statement/restriction | Critical comments for cutworm, wingless grasshopper2 and vegetable weevil – Apply when pests appear at or prior to planting or transplanting. Spraying should cover the soil out to at least 20 cm on both sides of row crop. Repeat once if required within 14 days of planting or transplanting. DO NOT apply more than 2 sprays.  To align with the nomenclature of Codex commodity classification and APVMA crop group guidance and to prevent confusion with other type of onions such as spring onions, the term ‘onions’ should be changed to ‘bulb onion’ on product labels. |
| Capsicum, eggplant | |
| Uses supported by Residues | Cutworm, grasshopper, weevil, crickets (bran baits) |
| Uses not supported by Residues | None |
| MRL1 | Eggplant – 0.2 mg/kg, sweet pepper (capsicum) – 1 mg/kg |
| WHP | Eggplant – 3 days, sweet peppers (capsicum) – 4 days |
| Other label statement/restriction | DO NOT use in protected-cropping situations |
| Citrus fruits | |
| Uses supported by Residues | Scale, grasshoppers, thrips, mealybug, ants, Queensland fruit fly and weevils |
| Uses not supported by Residues | None |
| MRL1 | 1 mg/kg for citrus and 5 mg/kg for citrus pulp (dry) |
| WHP | 14 days or Nil for butt and soil treatment |
| Other label statement/restriction | Nil |
| Coffee | |
| Uses supported by Residues | Mealybugs |
| Uses not supported by Residues | None |
| MRL1 | 0.05 mg/kg |
| WHP | Not required when used as directed |
| Other label statement/restriction | Nil |
| Cucumber and other cucurbits | |
| Uses supported by Residues | Cucumber: use at 750g ac/ha or less: Whiteflies, ants, mealybug, cutworm, wingless grasshopper, weevils, cricket (bran baits) |
| Uses not supported by Residues | Any use on cucurbits other than cucumber (e.g. melons, pumpkins, gourds, chokos, marrows and squashes). Cucumber: Any use above 750g ac/ha. |
| MRL1 | 1 mg/kg |
| WHP | 7 days |
| Other label statement/restriction | DO NOT use in protected-cropping situations. |
| Custard apple | |
| Uses supported by Residues | Ants |
| Uses not supported by Residues | None |
| MRL1 | 0.05 mg/kg |
| WHP | 14 days |
| Other label statement/restriction | Critical comments: Prune tree skirt off ground at end of each season. Do not contact fruit with spray |
| Grapes | |
| Uses supported by Residues | Light brown apple moth, grapevine moth, mealybug, tuber mealybug, grapevine scale |
| Uses not supported by Residues | None |
| MRL1 | 1 mg/kg |
| WHP | 14 days (foliar), Not Required when used as directed (dormant period) |
| Other label statement/restriction | Nil |
| Ginger, root | |
| Uses supported by Residues | Cutworm, African black beetle |
| Uses not supported by Residues | None |
| MRL1 | \*0.02 mg/kg |
| WHP | Not required when used as directed |
| Other label statement/restriction | Nil |
| Hops | |
| Uses supported by Residues | Common armyworm, southern armyworm and light brown apple moth |
| Uses not supported by Residues | None |
| MRL1 | 0.05 mg/kg |
| WHP | Not required when used as directed |
| Other label statement/restriction | DO NOT apply after flowering.  DO NOT graze or cut treated areas for stock food. |
| Kiwifruit | |
| Uses supported by Residues | Common armyworm, southern armyworms, scale insects, light brown apple moth |
| Uses not supported by Residues | None |
| MRL1 | 2 mg/kg |
| WHP | 14 days |
| Other label statement/restriction | Critical statement for armyworms and light brown apple moth – DO NOT apply post-bloom.  Critical statement for scale insects – DO NOT apply during blossom period. DO NOT use on edible peel kiwifruit varieties. |
| Leafy vegetables | |
| Uses supported by Residues | Lettuce, chard (silver beet): Cutworms, redlegged earth mite, blue oat mite, crickets (bran baits) and wingless grasshopper; Lettuce: vegetable weevil |
| Uses not supported by Residues | Chard (Silver beet): Vegetable weevil  All uses on leafy crucifers including chou moullier, kale, mustard, rape |
| MRL1 | Lettuce head – 1 mg/kg; lettuce leaf – 5 mg/kg and chard (silver beet) – 4 mg/kg |
| WHP | 14 days |
| Other label statement/restriction | DO NOT use in protected-cropping situations |
| Legume vegetables (garden peas, green beans) | |
| Uses supported by Residues | Cutworms, wingless grasshopper, vegetable weevil and crickets (bran baits) |
| Uses not supported by Residues | None |
| MRL1 | Legume vegetables – 1 mg/kg, legume animal feeds (except pulses) – 30 mg/kg |
| WHP | Harvest (legume vegetables) – 7 days, legume animal feeds – 28 days |
| Other label statement/restriction | DO NOT use in protected-cropping situations |
| Mango | |
| Uses supported by Residues | Scale |
| Uses not supported by Residues | None |
| MRL1 | 1 mg/kg |
| WHP | 21 days |
| Other label statement/restriction | Nil |
| Passionfruit | |
| Uses supported by Residues | Queensland fruit fly |
| Uses not supported by Residues | None |
| MRL1 | \*0.05 mg/kg |
| WHP | 14 days |
| Other label statement/restriction | Critical comment: Avoid contact with the fruit |
| Pineapple | |
| Uses supported by Residues | Mealybug, ants and white grub |
| Uses not supported by Residues | None |
| MRL1 | 0.5 mg/kg |
| WHP | Nil |
| Other label statement/restriction | Nil |
| Pome fruits | |
| Uses supported by Residues | Apples, pears: Light brown apple moth, San José scale (application in dormant period); Pome fruits (all): Queensland fruit fly, wingless grasshopper |
| Uses not supported by Residues | Foliar uses involving application at 50 g ac/100L which includes: Apples, pears: San José scale (application not in dormant period), woolly aphid, mealybug; Apples: Apple Dimpling bug |
| MRL1 | 0.7 mg/kg for pome fruit and 7 mg/kg for apple pomace (dry) |
| WHP | 14 days or Not Required when used as directed for dormancy spray |
| Other label statement/restriction | Nil |
| Root and tuber vegetables | |
| Uses supported by Residues | All root and tuber vegetables: Cutworm, crickets (bran baits), wingless grasshopper (barrier spray); Seed dressing (beetroot, carrot, radish, turnip): Cutworm, earwig, false wireworm, crickets, harvester ants and mole crickets; Cassava; cutworm; Potato: Vegetable weevil and soil applications – African black beetle, white fringed weevil and wireworm |
| Uses not supported by Residues | Light brown apple moth, earwig (band spray), redlegged earth mite and blue oat mite, wingless grasshopper (foliar), vegetable weevil (except potato) |
| MRL1 | 0.05 mg/kg |
| WHP | Not required when used as directed |
| Other label statement/restriction | Critical comments for wingless grasshopper: DO NOT use on crops. Apply only as a barrier across the line of advance when grasshoppers are invading the crops.  Critical comments for cutworm (root and tuber vegetables, except potato): DO NOT apply 14 days after seedling emergence  Critical comments for vegetable weevil (potato): DO NOT apply after the seedling growth stage. (Note – This should replace the current statement “one spray should be sufficient if applied at the seedling stage”.) |
| Stalk and stem vegetables (asparagus, celery, rhubarb) | |
| Uses supported by Residues | Asparagus, celery and rhubarb: Crickets (bran baits), cutworm, wingless grasshopper and vegetable weevil |
| Uses not supported by Residues | Foliar application on wingless grasshopper and vegetable weevil  All uses on stalk and stem vegetables except for asparagus, celery and rhubarb |
| MRL1 | 0.05 mg/kg for asparagus, celery and rhubarb |
| WHP | Not required when used as directed |
| Other label statement/restriction | Critical comments for cutworms, wingless grasshopper and vegetable weevil: Asparagus: Apply as a post-plant spray, up to 30 days before spear emergence. Do not spray the spears. Once harvest is complete, further applications are permissible, if required, up to 30 days before the next year’s spears emerge. Celery: Apply no later than 14 days after transplanting. For seedbeds, treatment can be at any time, up to the point of transplant lift. For field-seeded crops, DO NOT apply after the plants reach the minimum size of a transplant, approximately 8 weeks after seeding. Rhubarb2: Apply no later than 14 days after crown transplant.  Asparagus, celery, rhubarb: Remove critical comment “repeat as required”.  The term ‘stalk and stem vegetables (including asparagus, celery and rhubarb)’ should be changed to ‘asparagus, celery and rhubarb’ |
| Strawberry | |
| Uses supported by Residues | Field cricket, mole cricket |
| Uses not supported by Residues | None |
| MRL1 | 0.05 mg/kg |
| WHP | Not required when used as directed |
| Other label statement/restriction | Nil |
| Stone fruits | |
| Uses supported by Residues | Stone fruits (except peaches): European earwig (cracked-grain baits), San José scale, light brown apple moth and Queensland fruit fly. Peaches: European earwig (cracked-grain baits), light brown apple moth. Queensland fruit fly and San José scale (application in the dormant period only) |
| Uses not supported by Residues | Peaches: European earwig (foliar use), San José scale (application outside of dormant period) |
| MRL1 | Stone fruits (except peaches) – 1 mg/kg; Peaches – 0.05 mg/kg |
| WHP | Stone fruits (except peaches, foliar) – 14 days. Stone fruits (dormant period) – Not required when used as directed. Peaches – Not Required when used as directed. |
| Other label statement/restriction | Peaches: Critical comment for Queensland fruit fly – Avoid contact with fruit |
| Tomato | |
| Uses supported by Residues | Processing tomatoes: Tomato grubs, budworm, green vegetable bug, green peach aphids, whitefly, silverleaf whitefly, cutworm, wingless grasshopper, vegetable weevil, wireworm, false wireworm, African black beetle, crickets (bran baits); Fresh tomatoes: Uses up to 14 days after seeding/transplanting, crickets (bran baits, whole crop-life) |
| Uses not supported by Residues | None |
| MRL1 | Tomato – 1 mg/kg, tomato pomace – 10 mg/kg |
| WHP | 3 days (processing tomatoes), Not Required when used as directed (fresh tomatoes) |
| Other label statement/restriction | DO NOT use in protected-cropping situations  For uses other than baits, the following restraint applies to fresh tomatoes:  DO NOT apply later than 14 days after sowing or transplanting |

1 These MRL recommendations are reflective of the residue safety assessment outcomes only. Recommended amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023 are discussed in the below [Residues and trade recommendations](#_Recommendations).

2 Use is not considered practical with the required application timing restrictions based on pest activity in relevant crop growth stages.

Table 19: Summary of residue assessment outcomes for field crops and pasture

| Parameter | Assessment Outcome |
| --- | --- |
| Cereals | |
| Uses supported by Residues | Cereals: Armyworm, webworm, cutworms, locusts, redlegged earth mite, blue oat mite, fleas, grasshoppers, black-headed cockchafer and Seed dressing uses – curculio, seed harvesting ants, wireworms, false wireworms, black soil scarab, wheat root scarab, spine-tailed weevil, spotted vegetable weevil; Rice: Bloodworm, brown planthopper; Maize and sorghum: Wireworm, false wireworm, earwigs, cockroach and field cricket; Maize: African black beetle; Sorghum: Aphids, midges |
| Uses not supported by Residues | None |
| MRL1 | Cereals (except rice and sorghum) grains – 2 mg/kg, rice – 0.5 mg/kg, sorghum – 1 mg/kg, wheat bran (unprocessed) – 5 mg/kg  Cereal forage – 20 mg/kg, straw and fodder (dry) of cereal grains [except sorghum] – 10 mg/kg, sorghum fodder and straw (dry) – 20 mg/kg |
| WHP | Harvest and grazing – 14 days for all cereals except rice (10 days for harvest and grazing) and sorghum (7 days for harvest and grazing) |
| Other label statement/restriction | Nil |
| Cotton | |
| Uses supported by Residues | Armyworm, mites, cutworms, native budworm, cotton bollworm, locust, wingless grasshopper, earworm, cotton flea beetle, leaf beetle, springtail, aphids, brown field cricket, cockroaches, earwigs, wireworm and false wireworm |
| Uses not supported by Residues | None |
| MRL1 | MRL recommendations for oilseed apply for cotton seed, i.e. 0.05 mg/kg, forage – 30 mg/kg, straw – 20 mg/kg |
| WHP | Harvest and grazing – 28 days |
| Other label statement/restriction | Nil |
| Oilseeds (except cotton) | |
| Uses supported by Residues | Canola, linseed, peanut, safflower, sunflower: Cutworms, redlegged earth mite, blue oat mite, wingless grasshopper; Canola, safflower, sunflower: Wireworm and false wireworm; Canola: Lucerne flea, vegetable weevil, balaustium mite, brown pasture looper, bryobia mite, pasture webworm; Sunflower: Cockroaches, earwigs and field crickets; Seed dressing in oilseeds – False wireworm |
| Uses not supported by Residues | None |
| MRL1 | Oilseeds – 0.05 mg/kg, oilseed forage – 30 mg/kg, oilseed straw – 20 mg/kg |
| WHP | Harvest – Not required when used as directed (oilseeds, except cotton and peanuts), 14 days (peanuts).  Grazing (except cotton) – 14 days |
| Other label statement/restriction | Critical comment for wingless grasshopper and cutworm – DO NOT apply to canola, linseed, safflower or sunflower later than the 10 leaf stage |
| Pastures and forage crops | |
| Uses supported by Residues | Legume animal feeds (except pulses): Armyworm, locusts, mites, earwigs, lucerne flea, cutworms, caterpillars, cockchafer, leaf roller, aphids, sitonia weevil, webworms, budworm; Grass pastures: Armyworms, cutworms, locusts, mites, lucerne flea, wingless grasshopper, webworms, cockchafer, grass grubs, loopers, corbies, sitonia weevil |
| Uses not supported by Residues | None |
| MRL1 | Legume animal feeds (except pulses) and grass pastures – 30 mg/kg |
| WHP | Harvest and grazing – 28 days (legume animal feeds, except pulses) and 14 days (grass pastures) |
| Other label statement/restriction | Nil |
| Pulses | |
| Uses supported by Residues | All pulses: Redlegged earth mite and blue oat mite; Cowpeas, mung beans, navy beans, pigeon peas, chickpeas: Wireworms and false wireworm; Cowpeas: Brown field cricket; Soya bean: Cutworms, false wireworm, wingless grasshopper, cockroaches, crickets |
| Uses not supported by Residues | Armyworm, locusts, underground grass grub, looper, webworm |
| MRL1 | Pulse (dry) [except Soya bean (dry)] – 0.1 mg/kg, soya bean (dry) – 0.05 mg/kg, pulse forage – 5 mg/kg, pulse straw and fodder – 0.5 mg/kg |
| WHP | Harvest – Not required when used as directed (pulses, except soya bean), 28 days (soya bean)  Grazing – 28 days (all pulses) |
| Other label statement/restriction | Nil |
| Sugar cane | |
| Uses supported by Residues | Any foliar treatment, within 3 months following planting/ratooning |
| Uses not supported by Residues | Any foliar treatment applied later than 3 months after planting/ratooning |
| MRL1 | Sugar cane – \*0.01 mg/kg, Sugar cane fodder – 4 mg/kg |
| WHP | Harvest – Not required when used as directed, grazing – 14 days |
| Other label statement/restriction | DO NOT apply later than 3 months after planting or ratooning |

1 The MRL recommendations are reflective of the residue safety assessment outcomes only. Recommended amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023 are discussed in the below [Residues and trade recommendations](#_Recommendations).

## Animal transfer studies and animal commodity MRLs

Livestock transfer studies were previously in the [2000 chlorpyrifos residues assessment](apvma.gov.au/node/14741) (APVMA 2000a) and were also considered by the Joint Meeting on Pesticide Residues (JMPR) in 2000 (JMPR 2000). There were data for cattle, pigs, and poultry which were detailed in the 2009 [PRF report](apvma.gov.au/node/14761). No new studies have been submitted.

Currently the temporary MRLs in animal commodities are 0.1 mg/kg in mammalian edible offal, \*0.01 mg/kg in eggs, 0.5 mg/kg in mammalian fat, 0.2 mg/kg in milk fat, 0.1 mg/kg in poultry fat and poultry offal. Where the ‘\*’ denotes that the MRL is set at or about the limit of analytical quantitation.

Based on the residues safety assessment outcomes and livestock feed burden associated with currently approved uses, it was recommended that the:

* eggs MRL should be \*0.01 mg/kg
* poultry meat [in the fat] MRL should be 0.1 mg/kg
* poultry offal MRL should be \*0.01 mg/kg
* meat (mammalian)[in the fat] MRL should be 2 mg/kg
* mammalian edible offal MRL should be 0.02 mg/kg
* whole milk MRL should be 0.02 mg/kg
* milk fat MRL should be 0.5 mg/kg.

The contemporary assessment of worker health and safety, environment, residues and/or trade risk has not supported the use of chlorpyrifos in food-producing situations with the exception of the use of banana bags and cattle ear tags. The MRLs recommended above for mammalian livestock and poultry commodities were driven by uses in animal feeds that are not supported by the APVMA. The MRLs for cattle commodities (muscle, fat, offal, milk and milk fat) will be driven by the residues expected from the ear tag use.

Y-TEX Warrior Insecticidal Cattle Ear Tags (P51524) is a cattle ear tag impregnated with chlorpyrifos (100 g/kg) and diazinon (300 g/kg). This assessment has only considered residues of chlorpyrifos that may occur in milk and tissues of treated cattle. It is noted that an assessment of diazinon residues that may result from this product will occur as part of the ongoing review of diazinon. Each ear tag weighs 15 grams and therefore presents an exposure of 1.5 g chlorpyrifos per tag. One tag per animal is permitted, though it is noted that 2 ear tags were administered in 2 Australian tissue residue trials (Tozer 1996a; Tozer 1996b) and 2 Australian milk trials (Tozer 1996c; Tozer 1998). The residues expected in cattle milk (including milk fat), offal, muscle and fat from this ear tag product are summarised below.

Cattle milk and milk fat: The milk residue trials found that following a 2× treatment (2 ear tags per animal), the highest level of residues in milk fat were <0.02–0.046 mg/kg (mean = 0.027 mg/kg, day 1, pm). Given the treatment was at 2× dose rate, if residues are scaled to the maximum dose rate of 1 ear tag per animal, then the mean and highest residue are 0.014 and 0.023 mg/kg. A MRL for cattle milk fat at 0.05 mg/kg is considered appropriate for this ear tag use. Residues in milk were <0.02 mg/kg. It is considered that a MRL of \*0.02 mg/kg is appropriate for cattle milk.

Cattle offal: In one Australian study following 2× dose rate (2 ear tags), chlorpyrifos residues were <LOQ (<0.02 mg/kg) in kidney and liver. This data demonstrates that an MRL for ‘cattle, edible offal of’ of \*0.02 mg/kg is appropriate for this ear tag use.

Cattle muscle: In one Australian study following 2× dose rate (2 ear tags), chlorpyrifos residues were <LOQ (<0.02 mg/kg) in neck muscle and rump muscle. This data demonstrates that an MRL for cattle muscle of \*0.02 mg/kg is appropriate for this ear tag use.

Cattle fat: The highest residue in the 2 non-GLP Australian trials in fat was 0.067 mg/kg following a 2× dose rate (2 tags per animal), or 0.0335 mg/kg when scaled for the proposed rate. It is recommended that a MRL of 0.05 mg/kg for cattle fat is appropriate for this ear tag use with a 0-day meat withholding period. It is noted that in each of the 2 available tissue residue studies, chlorpyrifos residues fat peaked at 14 days after the administration of the cattle ear tag but residues were <LOQ (<0.01 mg/kg in one trial, <0.02 mg/kg in the other) after 28–29 days.

## Dietary exposure

An updated dietary exposure assessment has been undertaken based on the residue assessment outcomes, the revised ADI of 0.001 mg/kg bw/day and the revised ARfD of 0.03 mg/kg bw/day.

The chronic and acute dietary exposures of chlorpyrifos were acceptable for use patterns supported from a residues perspective (Table 18 and Table 19). Given that many uses are not supported by the APVMA review, the chronic and acute dietary exposure assessments have been revised to reflect the use patterns supported by the APVMA chemical review, namely use of chlorpyrifos impregnated banana bags and cattle ear tags.

### Chronic dietary exposure assessment

The chronic dietary exposure to chlorpyrifos is estimated by the National Estimated Daily Intake (NEDI) calculation encompassing all registered/temporary uses of chlorpyrifos and the mean daily dietary consumption data derived from the 2011–2012 National Nutritional and Physical Activity Survey. The NEDI calculation is made in accordance with World Health Organization (WHO) Guidelines and is a conservative estimate of dietary exposure to chemical residues in food. Based on the Australian uses and associated MRLs expected to remain as an outcome of this review, the NEDI for chlorpyrifos is equivalent to <30 % of the ADI. It is concluded that the chronic dietary exposure of chlorpyrifos is acceptable.

### Acute dietary exposure assessment

The acute dietary exposure to chlorpyrifos is estimated by the National Estimated Short-Term Intake (NESTI) calculation. The NESTI calculations are made in accordance with the deterministic method used by the JMPR with 97.5thpercentile food consumption data derived primarily from the 2011–2012 National Nutritional and Physical Activity Survey. NESTI calculations are conservative estimates of short-term exposure (24-hour period) to chemical residues in food. The maximum estimated acute dietary exposure for the uses supported by the APVMA review of chlorpyrifos was associated with cattle milk and was 5 % of the ARfD for the 2–6 years age group of 2 % for the general population (2+ years).

## Trade assessment

Commodities considered to be major export commodities are defined in the APVMA’s [Overseas trade (Part 5B) guidance](https://apvma.gov.au/node/1017). The presence of finite (measurable) residues of chlorpyrifos in major export commodities may pose a risk to Australian trade in situations where (i) no residue tolerance (import tolerance) is established in the importing country or (ii) where residues in Australian produce are likely to exceed a residue tolerance (import tolerance) established in the importing country.

Of the major export plant commodities, there are uses of chlorpyrifos in cereal grains, oilseeds (canola and cotton), pulses, citrus, grapes, pome fruit and stone fruit. Mammalian and poultry animal commodities which may be derived from livestock fed feeds produced from treated chlorpyrifos treated crops are also major export commodities. Sugar is a major export commodity; however, finite residues are not expected to occur in sugar cane treated with chlorpyrifos and the trade risk is therefore considered to be low.

### Trade risk assessment for plant commodities

For cereal grains, sorghum, rice, oilseeds (canola and cotton), pulses, citrus, grapes, pome fruit and stone fruit, a comparison of the current and proposed Australian MRLs with Codex and international MRLs (current as of October 2023) is detailed below in Table 20.

Table 20: Comparison of proposed Australian and current international chlorpyrifos MRLs for plant commodities

| Commodity | Chlorpyrifos MRLs (mg/kg) | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Australia (current) | Australia (proposed)1 | Codex2 | USA3 | EU4 | Japan5 | Korea6 | Taiwan7 |
| Cereal grains | T0.1 | 2 | – | – | \*0.01 | 0.5 (wheat and other cereal grains) | 0.4 (wheat) | \*0.02 (cereal grains) |
| Sorghum | T3 | 1 | – | – | \*0.01 | 0.5 (other cereal grains) | 0.5 | \*0.02 (cereal grains) |
| Rice | T0.1 | 0.5 | – | – | \*0.01 | – | – | \*0.02 (cereal grains) |
| Oilseeds | T0.01  (0.05 for cotton seed) | 0.05 | – | – | \*0.01 | 0.3 (cotton seed) | – | 0.5 (other cereals and crops) |
| Pulses | T0.05  (vegetables) | 0.1 | – | – | \*0.01 | 0.3 (beans, dried) | – | 0.1 (mung bean and small red beans) |
| Citrus fruits | T0.5 | 1 | – | – | \*0.01 | 1 | 1 | \*0.01 (vegetables and fruits) |
| Grapes | T1 | 1 | – | – | \*0.01 | 0.5 | – | \*0.01 (vegetables and fruits) |
| Pome fruit | T0.5 | 0.7 | – | – | \*0.01 | 0.5 (apple)  0.3 (pear) | 1 | \*0.01 (vegetables and fruits) |
| Stone fruit | T1 | 1 (except peaches which are 0.05) | – | – | \*0.01 | 1 (peach and nectarine)  0.5 (Japanese plum) | 0.5 (peach)  0.2 (plum) | \*0.01 (vegetables and fruits) |

1 The Australia (proposed) MRL is reflective of the residue assessment outcomes only. The Australian (proposed) MRLs reflective of the outcomes of all risk assessments, and corresponding amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023, are in the [Residues and trade recommendations](#_Recommendations).

2 The Codex Committee on Pesticide Residues at its 53rd meeting in July 2022 agreed to revoke all Codex MRLs as a public health concern was expressed and it was unlikely that data to complete risk assessment would be available. Details on this decision can be found on the [FAO website](https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-718-53%252FREPORT%252FFINAL%2BREPORT%252FREP22_PR53e.pdf).

3 All US tolerances for chlorpyrifos were revoked on 28 February 2022. Details on this decision can be found on the [Code of Federal Regulations website](https://www.ecfr.gov/current/title-40/chapter-I/subchapter-E/part-180/subpart-C/section-180.342).

4 Chlorpyrifos has not been approved in the European Union since 16/01/2020. MRLs established in the EU for chlorpyrifos can be found on the [EU Pesticides Database](https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/mrls/details?lg_code=EN&pest_res_id_list=56).

5 Japanese MRLs for Chlorpyrifos can be found on the [Japan Food Chemistry Research Foundation website](https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/mrls/details?lg_code=EN&pest_res_id_list=56).

6 Republic of Korea MRLs for chlorpyrifos can be found [Food Safety Korea websitehttps://www.foodsafetykorea.go.kr/foodcode/02\_01\_01.jsp?pesticide\_code=P00131&s\_option=EN&s\_type=2](https://www.foodsafetykorea.go.kr/foodcode/02_01_01.jsp?pesticide_code=P00131&s_option=EN&s_type=2).

7 Taiwanese MRLs for chlorpyrifos can be found on the [Taiwan Ministry of Justice website](https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=L0040083).

For cereal grains, oilseeds (canola and cotton), pulses, citrus, grapes, pome fruit and stone fruit which are major export commodities, the currently approved uses of chlorpyrifos may result in residues above 0.01 mg/kg which is the limit of quantification of the assessed analytical method and is the default MRL set of all commodities in the European Union. Given that Codex and the USA have revoked all MRLs for chlorpyrifos while the European Union have replaced previously established chlorpyrifos MRLs with a default value at \*0.01 mg/kg, and that MRL appropriate coverage in Japan, Korea and Taiwan is lacking for most of the major export commodities, it is considered that there may be an undue risk to international trade associated with the current uses in cereal grains, canola, cotton, pulses, citrus, grapes, pome fruit and stone fruit with exception of applications made prior to crop emergence or the end of dormancy.

For cereals, canola, cotton and pulses, available residues data found that median residues in grain were below the LOQ for post-harvest intervals of 100 days or more when applied at rates of 675 g ac/ha for cereals and oilseeds and 450 g ac/ha for pulses. Based on this information and given that pre-emergent applications of chlorpyrifos, a non-systemic insecticide, will be made prior to crop emergence, finite residues are not expected in exported grain. Therefore, the risk to trade associated with pre-emergent uses of chlorpyrifos on cereals, canola, cotton and pulses is considered to be low. For the application of chlorpyrifos during dormancy to grapes, pome fruit and stone fruit, finite residues are not expected in harvested fruit, and therefore the risk to trade for applications made during dormancy is considered to be low.

It is noted that the only use in plant commodities that is supported by the APVMA review of chlorpyrifos is the banana bag use. Bananas are not considered to be a major export commodity and therefore the trade risk associated with the banana bag use is not considered to be undue and is acceptable.

### Trade risk assessment for animal commodities

For human food commodities derived from mammalian livestock and poultry, a comparison of the current and proposed Australian MRL with Codex and international MRLs (current of October 2023) is detailed below in Table 21.

Table 21: Comparison of proposed Australian and current international chlorpyrifos MRLs for animal commodities

| Commodity | Chlorpyrifos MRLs (mg/kg) | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Australia (current) | Australia (proposed)1 | Codex2 | USA3 | EU4 | Japan5 | Korea6 | Taiwan7 |
| Mammalian meat [in the fat] | T0.5 | 2 | – | – | \*0.01 | 0.05 (0.01 for pig muscle and fat) | 1 (cattle and sheep)  0.02 (pig) | – |
| Mammalian offal | T0.1 | 0.02 | – | – | \*0.01 | 0.01 | 0.01 (cattle, sheep and pig) | – |
| Milk [in the fat] | T0.2 | 0.5 (whole milk 0.02) | – | – | \*0.01 | 0.01 | 0.02 | – |
| Poultry meat [in the fat] | T0.1 | 0.1 | – | – | \*0.01 | 0.01 | 0.01 | – |
| Poultry offal | T0.1 | \*0.01 | – | – | \*0.01 | 0.01 | 0.01 | – |
| Eggs | T\*0.01 | \*0.01 | – | – | \*0.01 | 0.01 | 0.01 | – |

1 The Australia (proposed) MRL is reflective of the residue assessment outcomes only. The Australian (proposed) MRLs reflective of the outcomes of all risk assessments, and corresponding amendments to Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023, are in the [Residues and trade recommendations](#_Recommendations).

2 The Codex Committee on Pesticide Residues at its 53rd meeting in July 2022 agreed to revoke all Codex MRLs as a public health concern was expressed and it was unlikely that data to complete risk assessment would be available. Details on this decision can be found on the [FAO website](https://www.fao.org/fao-who-codexalimentarius/sh-proxy/en/?lnk=1&url=https%253A%252F%252Fworkspace.fao.org%252Fsites%252Fcodex%252FMeetings%252FCX-718-53%252FREPORT%252FFINAL%2BREPORT%252FREP22_PR53e.pdf).

3 All US tolerances for chlorpyrifos were revoked on 28 February 2022. Details on this decision can be found on the [Code of Federal Regulations website](https://www.ecfr.gov/current/title-40/chapter-I/subchapter-E/part-180/subpart-C/section-180.342).

4 Chlorpyrifos has not been approved in the European Union since 16/01/2020. MRLs established in the EU for chlorpyrifos can be found on the [EU Pesticides Database](https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/mrls/details?lg_code=EN&pest_res_id_list=56).

5 Japanese MRLs for Chlorpyrifos can be found on the [Japan Food Chemistry Research Foundation website](https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/start/screen/mrls/details?lg_code=EN&pest_res_id_list=56).

6 Republic of Korea MRLs for chlorpyrifos can be found [Food Safety Korea websitehttps://www.foodsafetykorea.go.kr/foodcode/02\_01\_01.jsp?pesticide\_code=P00131&s\_option=EN&s\_type=2](https://www.foodsafetykorea.go.kr/foodcode/02_01_01.jsp?pesticide_code=P00131&s_option=EN&s_type=2).

7 Taiwanese MRLs for chlorpyrifos can be found on the [Taiwan Ministry of Justice website](https://law.moj.gov.tw/ENG/LawClass/LawAll.aspx?pcode=L0040083).

The 2009 PRF report concluded that, to comply with the target MRL/tolerance of the most sensitive export destination for animal commodities (in this case, the EU’s 0.01 mg/kg MRL), it is necessary to set the time required on clean feed (Export Slaughter Intervals, ESIs) for different animal species. The ESIs in the 2009 PRF report that are applicable to each species are 56 days for grazing animals (e.g., cattle, sheep and goats) and 7 days for pigs. Given the ESI endpoint of 0.01 mg/kg was used in the 2009 PRF, and that 0.01 mg/kg is the limit of quantification for analytical methods in animal commodities, the previous ESI recommendations in the 2009 PRF should mitigate the risk to trade for animal commodities following use as a pesticide on animal feeds. It is however noted that uses on animal feeds is not supported from a worker health and safety and environment perspective.

Cattle ear tag use is supported by worker health and safety and environment assessments of chlorpyrifos. This use pattern would result in exposure to livestock. Cattle commodities are major export commodities and finite residues in fat are expected to result from the proposed use with a 0-day withholding period. Given that Codex and the USA have revoked all MRLs for chlorpyrifos while the European Union have replaced previously established chlorpyrifos MRLs with a default value at \*0.01 mg/kg, an Export Slaughter Interval (ESI) of 28 days after administration of the ear tag is recommended to ensure that residues are <LOQ and prevent an undue risk to international trade. Therefore, the following ESI is recommended for Y-TEX Warrior Insecticidal Cattle Ear Tags (P51524):

EXPORT SLAUGHTER INTERVAL (ESI): DO NOT administer this ear tag product less than 28 days before slaughter for export. Before using this product, confirm the current ESI from Landmark Operations Limited on 1800 448 892 or the APVMA website (apvma.gov.au/residues).

## Residues and trade recommendations

The following uses of chlorpyrifos on food crops are not supported based on potential risks identified in the residues assessment, including due to data gaps or acute dietary exposure concerns:

* Post-planting, foliar use on brassica vegetables (i.e. the control of butterflies, moths, caterpillars, aphids, budworm and corn earworms)
* Post-planting, foliar use on root and tuber vegetables other than potato (i.e. the control of light brown apple moth, earwig, redlegged earth mite and blue oat mite, wingless grasshopper and/or vegetable weevil in beetroot, carrots, parsnip, radishes, sweet potato, swede and/or turnips)
* Use on cucurbits other than cucumber
* Foliar use on peaches
* Use on pome fruit (apples and pears) at an application rate of 50 g ac/100 L
* Use on chard (silver beet) for control of vegetable weevil at 400 g ac/ha
* Use on cucumbers at an application rate that exceed 750 g ac/ha
* Use on kiwifruit with edible peel

The uses of chlorpyrifos on the major export commodities cereal grains, sorghum, rice, canola, cotton, pulses, citrus, grapes, pome fruit and stone fruit are not supported based on potential risks to international trade, with the exception of applications made to cereals, canola, cotton and pulses prior to crop emergence or applications made to grapes, pome fruit and stone fruit prior to the end of dormancy.

While a number of chlorpyrifos use patterns could be supported from a residues and trade perspective, the contemporary assessment of worker health and safety and environmental risks has not supported the use of chlorpyrifos in food-producing situations with the exception of the use of banana bags, a specific use on oilseeds (except canola and cotton) made prior to emergence at a maximum rate of 110 g ac/ha, and cattle ear tags.

The specific use on oilseeds (except canola and cotton) involving pre-emergent application at 110 g ac/ha cannot be supported from a Residues and Trade assessment due to a lack of residues data relevant to that use pattern.

The uses of chlorpyrifos in banana bags and cattle ear tags are supported from a residues and trade perspective, however the following Export Slaughter Interval should be added to the product label of the cattle ear tag product to prevent an undue risk to international trade:

EXPORT SLAUGHTER INTERVAL (ESI): DO NOT administer this ear tag product less than 28 days before slaughter for export. Before using this product, confirm the current ESI from Landmark Operations Limited on 1800 448 892 or the APVMA website (apvma.gov.au/residues).

### Amendments to the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023

Table 22 and Table 23 include the recommended MRL changes in the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023 which will be required as an outcome of the review of registered products. MRLs established for minor use permits and a corresponding entry in Table 5 of the MRL Standard for Residues of Chemical Products Instrument 2023 will be reconsidered separately, and additional amendments may be required after consideration of these permit uses. MRLs for registered uses not supported by the APVMA chemical review will be deleted after the completion of any phase out period. The MRL for bananas will be driven by the residues expected from the banana bag use while MRLs for cattle commodities (muscle, fat, offal, milk and milk fat) will be driven by the residues expected from the ear tag use.

Table 22: Amendments to Table 1 of the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023

| Code | | Commodity | MRL (mg/kg) | |
| --- | --- | --- | --- | --- |
| DELETE | ADD |
| VS | 0621 | Asparagus | T0.5 |  |
| FI | 0326 | Avocado | 0.5 |  |
| FI | 0327 | Banana | T0.5 | 0.2 |
| VB | 0040 | Brassica (cole or cabbage) vegetables, Head cabbages, Flowerhead brassicas | T0.5 |  |
| VR | 0463 | Cassava | T\*0.02 |  |
| MO | 0812 | Cattle, edible offal of |  | \*0.02 |
| MF | 0812 | Cattle fat |  | 0.05 |
| ML | 0812 | Cattle milk |  | \*0.02 |
| FM | 0812 | Cattle milk fat |  | 0.05 |
|  |  | Cattle muscle |  | \*0.02 |
| VS | 0624 | Celery | T5 |  |
| GC | 0080 | Cereal grains {except sorghum} | T0.1 |  |
| FC | 0001 | Citrus fruits | T0.5 |  |
| SB | 0716 | Coffee Beans | T0.5 |  |
| SO | 0691 | Cotton seed | 0.05 |  |
| OC | 0691 | Cotton seed oil, crude | 0.2 |  |
| DF | 0167 | Dried fruits | T2 |  |
| MO | 0105 | Edible offal (mammalian) | T0.1 |  |
| PE | 0112 | Eggs | T\*0.01 |  |
| HS | 0784 | Ginger, root | \*0.02 |  |
| FB | 0269 | Grapes | T1 |  |
| FI | 0341 | Kiwifruit | 2 |  |
| VA | 0384 | Leek | T5 |  |
| FI | 0345 | Mango | \*0.05 |  |
| MM | 0095 | Meat (mammalian)[in the fat] | T0.5 |  |
| ML | 0106 | Milks [in the fat] | T0.2 |  |
| SO | 0089 | Oilseed, except peanut | T0.01 |  |
| SO | 0697 | Peanut | T\*0.01 |  |
| FA | 0351 | Passion fruit | \*0.05 |  |
| VO | 0445 | Peppers, sweet [capsicums] | T1 |  |
| FI | 0353 | Pineapple | T0.5 |  |
| FP | 0009 | Pome fruits | T0.5 |  |
| VR | 0589 | Potato | 0.05 |  |
| PO | 0111 | Poultry, Edible offal of | T0.1 |  |
| PM | 0110 | Poultry meat [in the fat] | T0.1 |  |
| GC | 0651 | Sorghum | T3 |  |
| FS | 0012 | Stone fruits | T1 |  |
| FB | 0275 | Strawberry | 0.05 |  |
| GS | 0659 | Sugar cane | T0.1 |  |
| VR | 0497 | Swede | T0.3 |  |
| VR | 0508 | Sweet Potato | T0.05 |  |
| VR | 0505 | Taro | 0.05 |  |
| VO | 0448 | Tomato | T0.5 |  |
|  |  | Vegetables [except asparagus; brassica vegetables; cassava; celery, leek; peppers, sweet [capsicums]; potato; swede; sweet potato; taro; tomato] | T\*0.01 |  |

Table 23: Amendments to Table 4 of the Agricultural and Veterinary Chemicals (MRL Standard for Residues of Chemical Products) Instrument 2023

| Code | | Commodity | MRL (mg/kg) | |
| --- | --- | --- | --- | --- |
| DELETE | ADD |
| AM | 0691 | Cotton fodder, dry | 30 |  |
|  |  | Cotton meal and hulls | 0.05 |  |
|  |  |  |  |  |
| AL | 1270 | Peanut forage (green) | T10 |  |
|  |  | Peanut hay | T2 |  |

# Environment

## Previous assessments

In 2000, an [interim environmental risk assessment](apvma.gov.au/node/14756) for chlorpyrifos on the environmental fate and effects was published by the APVMA (2000c). As an outcome, various risk management recommendations were implemented to reduce environmental risks including label warnings for environmental protection and establishment of buffer zones for various use patterns.

In 2019, a [supplementary environment assessment report](https://apvma.gov.au/node/50116) was published by the APVMA (2019c), which provided recommendations to address the environmental risks of home garden, domestic and certain agricultural uses. For spray applications, the assessment determined that single application rates above 850 g ac/ha were not acceptable to birds and the possibility of avian mortality was likely under field conditions. Therefore, certain home garden/urban use products with usage rates >850 g ac/ha were cancelled. The 850 g ac/ha threshold also applied for the protection of birds in agricultural situations.

## Current assessment

The current assessment considers the environmental risks of the remaining registered uses of chlorpyrifos; however, many that are not supported based on human health or food safety grounds have not been reconsidered in the interest of efficiency.

Chlorpyrifos is primarily applied as a broadcast foliar spray to crops and other plants for control of various insect pests, but it can also be applied as a dry granular formulation, seed treatment, or bait. It is also registered for control of mosquito larvae in polluted water impounds and as a termiticide.

The environmental risk assessment scenarios considered in the current assessment are summarised in Table 24. Environmental risks were determined according to the methodology outlined in the [APVMA Risk Assessment Manual – Environment](https://apvma.gov.au/node/46416).

Table 24: Environmental risk assessment scenarios

| Category | Situation | Risk assessment scenario |
| --- | --- | --- |
| Treated materials | Ear tags, banana bags, hides/skins | Negligible exposure of the environment |
| Field crops and pasture | Pasture, lucerne, sugarcane, forage crops, oilseeds (excluding cotton and canola) | 2× 350 g ac/ha 7-day retreatment interval |
|  | Duboisia | 1× 450 g ac/ha |
| Tree and vine crops | Avocado (spot application) | 1× 500 g ac/ha  (25 g ac/100 L, 2000 L/ha) |
|  | Grapevines, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards | 1× 250 g ac/ha  (50 g ac/100 L, 500 L/ha) |
|  | Grapevine rootlings | Incorporated granules: 8000 g ac/ha (2 g ac/vine at 4000 vines/ha) |
| Vegetable crops | Vegetables (band application) | 2× 400 g ac/ha 7-day retreatment interval |
|  | Vegetables (broadcast application) | 2× 350 g ac/ha 7-day retreatment interval |
|  | Ginger | 1× 450 g ac/ha |
| Seed dressings | Vegetable seeds | 25000 mg ac/kg seed |
|  | Cereal seeds | 2000 mg ac/kg seed |
|  | Oilseed seeds | 400 mg ac/kg seed |
| Insect baits | Maize, sorghum, soybeans, stone fruit, sunflower, turf | 200 mg ac/kg grain bait |
|  | Strawberries, vegetables | 50 mg ac/kg grain bait |
| Ornamentals | Tasmanian blue gum planting hole soil | Planting out: 1500 g ac/ha (1.5 g ac/plant, 1000 plants/ha) |
|  | Potted ornamental soil | Planting out: 4000 g ac/ha (100 mg ac/kg soil, 4 kg soil/plant, 10000 plants/ha) |
|  | Potted ornamentals (beetle larvae) | Soil drench: 4000 g ac/ha (20 g/100 L, 2 L/m2) |
|  | Potted ornamentals (ant control) | Surface spray: 5000 g ac/ha (125 g ac/25 L, 1000 L/ha) |
| Crawling insect control | In and around buildings | Surface spray: 5000 g ac/ha |
|  | Ant nests and trails | Surface granules: 1000 g ac/ha |
| Mosquito control | Vegetation (mosquito adults) | 4× 54 g ac/ha 7-day retreatment interval |
|  | Polluted water impoundments (mosquito larvae) | 105 µg ac/L |
| Commercial turf | Spot spray to funnel ant mounds | Negligible exposure of the environment |
|  | Control of cockchafer, grub or corbie | 1× 450 g ac/ha |
|  | Control of other insect pests | 2× 350 g ac/ha 7-day retreatment interval |
| Termite management | External perimeter treatment (horizontal or vertical) around large buildings | 1000 kg ac/ha |
|  | New and existing poles | 1000 kg ac/ha |
|  | Chemical barrier (horizontal or vertical) under structure, direct treatment of nest or colony | Negligible exposure of the environment |
| Combination products containing bifenthrin | Subterrannean clover, clover, lucerne | 2× 400 g ac/ha 7-day retreatment interval |
|  | Field tomatoes | 2× 250 g ac/ha 7-day retreatment interval |

## Fate and behaviour in the environment

The fate and behaviour of chlorpyrifos in the environment have been described in the previous APVMA 2000c and 2019c assessments. A full listing of endpoints is provided in Appendix B.

Chlorpyrifos is non-persistent in soil under field conditions (geomean DT50 28 days) and is slightly mobile (geomean Kfoc 3572 mL/g). In aquatic systems, chlorpyrifos is moderately persistent (geomean DT50 42 days) with up to 54% partitioning to sediment. It is not expected to undergo long-range transport through the air based on rapid reaction with hydroxyl radicals.

Lu et al. (2014) reports persistence and dissipation of chlorpyrifos in brassicas, lettuce, celery, asparagus lettuce (celtuce), eggplant and pepper. The application rate in the studies was 970 g ac/ha, and measured DT50 values were 5.8, 3.9, 5.4, 3.9, 2.6 and 3.0 days, respectively. The geometric mean of these half-lives is 4.0 days.

Insect DT50 values were also determined for both ground-dwelling species (DT50 4.0 days) and foliage-dwelling species (DT50 3.1 days) based on residue data available from an avian field study where citrus was treated with 2400 g ac/ha. The geometric mean of these half-lives is 3.5 days.

Regression analysis of the adsorption data indicate that sorption of chlorpyrifos increases as the organic carbon increased (Kd = 42 \* %OC +25). There are measured data available for total organic carbon in agricultural soils around Australia and these are published by [Soil Quality Pty Ltd](https://www.soilquality.org.au/). While not all agricultural regions are represented, the data allow for a relatively good assessment of differences in organic carbon levels in different regions of States and some different agricultural uses (for example, dryland and horticulture). The fraction of contribution of different soil organic carbon levels in different regions has been assessed to determine appropriate levels for different cropping types in different parts of the country. These are applied broadly in the runoff assessment here to differentiate between levels of organic carbon that may be found between states in dryland cropping and horticulture. The results will have a strong influence on the runoff assessment. Based on that analysis, the organic carbon levels in the top 10 cm soil have been adopted for the different states, and the corresponding Kd values from the above relationship derived for use in the runoff assessment (Table 26).

Table 25: Key regulatory endpoints for exposure assessment

| Compartment | Value | Reference |
| --- | --- | --- |
| Foliage and other dietary items | DT50 4.0 d | Lu et al. 2014 |
| Insects | DT50 3.5 d | Wilkens et al. 2008a |
| Soil | DT50 28 d | Fontaine et al. 1987, Old 2002b, Old 2002c, Old 2002d |
|  | 1% OC: Kd 67 mL/g  2% OC: Kd 108 mL/g | Damon & Heim 2001 |
| Water | DT50 42 d | Abu 2015b, Kang 2015 |
| Sediment | DT50 42 d | Abu 2015b, Kang 2015 |
|  | 5% OC: Kp 236 mL/g | Damon & Heim 2001 |
| Air | DT50 1.4 h | Simon 2001 |

Table 26: Summary of % organic carbon and corresponding Kd for runoff assessments

| State | Horticulture | | Dryland | |
| --- | --- | --- | --- | --- |
|  | % organic carbon | Kd (mL/g) | % organic carbon | Kd (mL/g) |
| Western Australia | 2.0 | 108 | 1.0 | 67 |
| South Australia | 1.5 | 88 | 1.3 | 77 |
| Victoria | 2.0 | 108 | 1.0 | 67 |
| Tasmania | 4.0 | 194 | 4.0 | 194 |
| New South Wales | 2.0 | 108 | 1.5 | 88 |
| Queensland | 2.0 | 108 | 1.0 | 67 |

## Effects on non-target species

The effects of chlorpyrifos on non-target species have been described in the previous APVMA 2000c and 2019c assessments. A full listing of endpoints is provided in Appendix B.

Chlorpyrifos has high toxicity to mammals (LD50 97 mg ac/kg bw/d, *Rattus norvegicus*) and birds (geomean LD50 32 mg ac/kg bw/d, 14 species). Therefore, the following hazard statement is advised for chlorpyrifos product labels (followed by an appropriate risk management statement).[[4]](#footnote-5)

Toxic to birds and wild mammals.

The major metabolites TMP, TCP, and DCP have low toxicity to mammals; TCP has low toxicity to birds.

Following long-term dietary exposure to chlorpyrifos, neonatal effects were observed in mammals at doses at low as 5.0 mg ac/kg bw/d (NOEL 1.0 mg ac/kg bw/d, *Rattus norvegicus*), and significant impairment of avian reproductive success was observed at concentrations as low as 125 ppm (NOEL 2.9 mg ac/kg bw/d, *Anas platyrhynchos*).

Chlorpyrifos has high toxicity to fish (lowest LC50 0.010 mg ac/L, *Leuciscus idus*), aquatic invertebrates (lowest LC50 0.000045 mg ac/L, *Mysidopsis bahia*), and moderate toxicity to algae (lowest ErC50 1.0 mg ac/L, *Pseudokirchneriella subcapitata*). Therefore, the following protection statement is advised for chlorpyrifos product labels.

Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.

The major metabolites TMP, TCP and DCP are less toxic than the parent substance to aquatic species.

Following long-term exposure to chlorpyrifos, increased mortality was observed in fish in the early life stages at concentrations as low as 0.00078 mg ac/L (lowest NOEC 0.00038 mg ac/L, *Menidia peninsulae*), and reduced growth and survival of aquatic invertebrates was observed at concentrations as low as 0.000010 mg ac/L (lowest NOEC 0.0000046 mg ac/L, *Mysidopsis bahia*).

As described by APVMA (2019c) and based on higher tier (microcosm/mesocosm) data, the consistent finding was a NOEC value of 0.10 µg ac/L for the most sensitive aquatic species. This value was set as the RAL for protection of aquatic species for both runoff and spray drift assessments.

Available data show concern for bioconcentration of chlorpyrifos in aquatic species with BCF values of 1,374 in fish (Murphy & Luteske 1986) and 430–680 in bivalves (Hansen et al. 1992, Thacker et al. 1992).

Three studies on aquatic vertebrates are available to assessment the potential for endocrine disruption (Coady et al. 2012, 2015; Currie et al. 2011); however, it was not possible to discern whether adverse effects were observed due to endocrine disruption or other mode of action.

Chlorpyrifos has high toxicity to adult bees by contact exposure (geomean LD50 0.075 µg ac/bee, *Apis mellifera*) and oral exposure (geomean LD50 0.21 µg ac/bee, *Apis mellifera*), and high toxicity to bee larvae (LD50 0.021 µg ac/bee, *Apis mellifera*). A representative EC formulation is approximately equivalent in toxicity to the technical substance. Tunnel tests in flowering *Phacelia tanaetafolia* at an application rate of 1000 g ac/ha indicate residues impact the foraging activity of bees for at least 14 days after application. The following hazard statement is advised for chlorpyrifos product labels (followed by an appropriate risk management statement).[[5]](#footnote-6)

Highly toxic to bees.

For the spray drift assessment for the protection of pollinators, the RAL is 12 g ac/ha based on the geomean contact LD50 0.075 µg ac/bee and a conversion factor of LOC 0.4/ExpE 2.4 ×1000 as per the [APVMA’s Spray drift risk assessment manual](https://apvma.gov.au/node/51826) (SDRAM).

There are no contemporary laboratory data on the toxicity of chlorpyrifos to predatory and parasitic arthropods. Available extended laboratory data on a representative EC formulation show complete mortality of the ladybird beetle *Coccinella septempunctata* at rates as low as 180 g ac/ha (Thomas & Phadke 1991), and complete inhibition of parasitisation capacity of rove beetle *Aleochara bilineata* at 960 g ac/ha (Moreth 1992). Field studies at 960 g ac/ha in pome fruit and 720 g ac/ha in grassland demonstrate a high initial toxicity to arthropod populations, but most species recovered within 23 days in pome fruit and within one year in grassland. Based on the available data, chlorpyrifos products are not considered to be compatible with integrated pest management programs utilising beneficial arthropods. Therefore, the following protection statement is advised for chlorpyrifos agricultural product labels.[[6]](#footnote-7)

Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.

Chlorpyrifos and a representative EC formulation are moderately toxic to soil macro-organisms such as earthworms (geomean LC50corr 130 and 76 mg ac/kg dry soil, respectively). Following long-term exposure, reduced reproduction was observed at concentrations as low as 27 mg ac/kg dry soil (NOECcorr 6.4 mg ac/kg dry soil). Chlorpyrifos does not affect soil processes such as nitrogen transformation at exaggerated soil concentrations (lowest NOEC 6.4 mg ac/kg dry soil). Although the minor soil metabolites TMP and DCP are more toxic than the parent substance to soil macro-organisms, they are formed in small quantities and the assessment of chlorpyrifos is considered to address their risks.

The toxicity of 4 major chlorpyrifos formulation to non-target terrestrial plants has been tested following pre-emergent and post-emergent exposure. All ER25 values are >2,400 g ac/ha.

Based on the available data, the regulatory acceptable levels for the environmental risk assessment are summarised in Table 27.

Table 27: Regulatory acceptable levels for non-target species

| Group | Exposure | Endpoint | AF | RAL | Reference |
| --- | --- | --- | --- | --- | --- |
| Mammals | Acute | LD50 97 mg ac/kg bw | 10 | 9.7 mg ac/kg bw | Henck & Kociba 1980 |
| Chronic | NOEL 1.0 mg ac/kg bw/d | 1 | 1.0 mg ac/kg bw/d | Breslin et al. 1991 |
| Birds | Acute | LD50 32 mg ac/kg bw | 10 | 3.2 mg ac/kg bw | Bull & Cameron 2013, Gallagher et al. 1996, Hudson et al. 1972, 1984, Lloyd et al. 1989a, 1989b, Miyazaki & Hodgson 1972, Rodgers 1996, Schafer & Brunton 1971, 1979, Sharma 2008a, Sherman et al. 1967, Smith 1987, Stevenson 1963, Yogeesh 2014 |
| Chronic | NOEL 2.9 mg ac/kg bw/d | 1 | 2.9 mg ac/kg bw/d | Lloyd et al. 1990 |
| Aquatic species | Acute/chronic | NOEC 0.00010 mg ac/L | 1 | 0.00010 mg ac/L | Daam 2008, Giddings 1993, 2011, López-Mancisidor 2015, López-Mancisidor et al. 2008, van den Brink et al. 1996, van Wijngaarden et al. 2005 |
| Adult bees | Acute contact | LD50 0.075 µg ac/bee | 2.5 | 0.030 µg ac/bee | Bell 1994, Suresh 2015 |
|  | Acute oral | LD50 0.21 µg ac/bee | 2.5 | 0.084 µg ac/bee | Bell 1994, Sharma 2008b, Suresh 2015 |
| Bee larvae | Acute oral | LD50 0.021 µg ac/bee | 2.5 | 0.0084 µg ac/bee | Odemer 2015 |
| Soil macro-organisms | Acute | LC50corr 76 mg ac/kg ds | 10 | 7.6 mg ac/kg ds | Johnson 1993, Candolfi 1995 |
| Chronic | NOECcorr 6.4 mg ac/kg ds | 1 | 6.4 mg ac/kg ds | Hayward 2002 |
| Soil micro-organisms | Chronic | NOEC 6.4 mg ac/kg ds | 1 | 6.4 mg ac/kg ds | Baloch & Hund 1990, Baloch & Todt 1990 |
| Terrestrial plants | Pre-emergent | ER25 >2400 g ac/ha | 2 | 1200 g ac/ha | Paterson & Toft 2007a |
| Post-emergent | ER25 >2400 g ac/ha | 2 | 1200 g ac/ha | Paterson & Toft 2007b |

## Risks to non-target species

### Terrestrial vertebrates

In the supplementary environment assessment report published in 2019, acute exposure of birds represented the highest risk to terrestrial vertebrates, and any mitigation measures in this area were considered protective of chronic exposure and native mammals (acute and chronic). An upper application rate of 850 g ac/ha was supported for protection of birds following direct dietary exposure of potentially oversprayed food items.

In light of new assessment methodology practiced since the previous assessment was published, risks to terrestrial vertebrates have been reconsidered. The assessment determined that acute risks to birds are still significantly higher than long term risks to birds. Therefore, the previous approach of applying an acute risk index to determine the maximum allowable rate for avian exposure is still accepted. However, the risks to mammals from long-term exposure have been determined to be significantly higher than previously assessed. The summary of outcomes for the wild mammal assessments are reported in Appendix C. No outcomes were identified as acceptable for long-term risk to mammals from these field uses with the exception of oilseeds. Oilseeds were supported up to a seasonal rate of 110 g ac/ha which overlaps the registered rate for control of redlegged earth mite and blue oat mite.

Application rates for potted ornamentals, termite protection and for crawling insect control are considerably higher; however, direct dietary exposure of contaminated food items is considered negligible following spot application or application in protected environments. Therefore, direct dietary exposure risks to terrestrial vertebrates are acceptable for these use patterns. For the granular products to be sprinkled lightly around ant nests and trails, the following restraints are required.

DO NOT use in areas easily accessible to birds and wild mammals. To protect birds and wild mammals, remove spillages.

One product (50416) is applied as granules for use in grapevine rootlings. The granular acute assessment for birds ingesting granules with or as grit follows EFSA (2009) and is reported in Table 29. The risk is unacceptable and while it is a screening level assessment, no further refinement can be undertaken with the available data. The incorporation by using a hand rake or like implement is not applicable for reducing exposure because the incorporation depth is only 2–4 cm and there is no information on incorporation efficiency. Up to 99% incorporation efficiency would be required for exposure to be reduced to acceptable levels. This is not considered likely. For example, even with drilling seeds, Northern Zone (2021) reports incorporation efficiencies of around 90% for standard and precision drilling of wheat and canola, respectively in headland areas and these would be expected to be more efficient than shallow incorporation using a hand rake.

The same product (50416) is registered for use in ornamental nursery plants and Tasmanian blue gum for use when planting from containers to the field. However, in both cases, direct dietary exposure of birds and mammals is likely to be low as application is by thorough mixing with the container media prior to planting, or by mixing with the soil in the planting hole at the transplanting operation. The following restraint is required for this product.

To protect birds and wild mammals, the product must be entirely incorporated into the soil. Remove spillages.

For seed dressings and insect baits, the screening level assessments assume that birds feed entirely on readily available, freshly treated seeds or grain baits. An additional assessment assumes that small omnivorous birds consume newly emerged crop shoots from treated seeds. Acceptable risks could not be concluded at the lowest treatment rates of 400 mg ac/kg seed (Table 30) or 50 mg ac/kg bait (Table 31). There are no field studies available to address avian risks in these use situations. There are a number of factors that can be considered to refine the assessments; however, it is noted that these uses are not supported from a worker safety perspective. Therefore, the avian risk assessment for seed dressings and insect baits have not been refined any further.

The log Pow 4.9 for chlorpyrifos indicates a potential for bioaccumulation. As bioaccumulation processes are often slow, a chronic assessment is appropriate. The food chain assessment for fish-eating species assumes that the RAL for aquatic species is not exceeded on the basis that only use situations with acceptable risks to aquatic species will be approved. Provided water concentrations do not exceed the aquatic RAL, any accumulated residues in fish will not reach levels harmful to predators. The food chain assessment for earthworm-eating species is not specific to the actual cropping situation, rather it depends on the application rates, frequency and timing. There are a range of application practices considered for field uses of chlorpyrifos. An iterative approach to the bioaccumulation assessment has been performed. A maximum seasonal soil exposure rate of 76 g ac/ha was determined to be acceptable to earthworm-eating species. After considering treatment areas are relatively small, ornamental uses (including Tasmanian blue gum planting soil) and adult mosquito control were determined to be acceptable to earthworm-eating mammals. Use in oilseeds is also supported at a maximum seasonal rate of 110 g ac/ha. Seasonal catchment exposure rates for these uses were 76 g ac/ha and below (see Appendix B for details).

These findings are consistent with the assessment by the Persistent Organic Pollutants Review Committee (POPRC) for chlorpyrifos showing that chlorpyrifos has been found in biota at different trophic levels in remote regions, in apex predators and in human breast milk, which is a concern for offspring. It was considered there was sufficient evidence that chlorpyrifos meets the Stockholm Convention criterion on bioaccumulation (Appendix E).

Table 28: Chlorpyrifos – Summary of risk assessment outcomes for long-term effects on wild mammals

| Situation | Rate  (g ac/ha) | Number | Interval  (d) | Direct dietary  assessment | Food chain  assessment | Max seasonal  rate supported |
| --- | --- | --- | --- | --- | --- | --- |
| Pasture, lucerne, sugarcane, forage crops | 350 | 2 | 7 | **Not supported** | **Not supported** | 28 g ac/ha |
| Oilseeds (excluding cotton and canola) | 350 | 2 | 7 | **Not supported** | **Not supported** | 110 g ac/ha |
| Duboisia | 450 | 1 | – | **Not supported** | **Not supported** | 28 g ac/ha |
| Ginger | 450 | 1 | – | **Not supported** | **Not supported** | 92 g ac/ha |
| Spot application in avocado | 250 | 1 | – | **Not supported** | **Not supported** | 69 g ac/ha |
| Other tree and vine crops | 250 | 1 | – | **Not supported** | **Not supported** | 28 g ac/ha |
| Macrocarpa hedges around orchards | 250 | 1 | – | **Not supported** | **Not supported** | 28 g ac/ha |
| Grapevine rootlings | 8000 | 1 | – | **Not supported** | **Not supported** | n/a |
| Band application in vegetables | 400 | 2 | 7 | **Not supported** | **Not supported** | 55 g ac/ha |
| Broadcast application in vegetables | 350 | 2 | 7 | **Not supported** | **Not supported** | 28 g ac/ha |
| Tasmanian blue gum planting hole soil | 1500 | 1 | – | Negligible exposure | Acceptable risk | n/a |
| Potted ornamentals | 5000 | 1 | – | Negligible exposure | Acceptable risk | n/a |
| Crawling insect control | 5000 | 1 | – | Negligible exposure | Negligible exposure | n/a |
| Control of adult mosquitos in vegetation | 54 | 4 | 7 | **Not supported** | Acceptable risk | 28 g ac/ha |
| Control of cockchafer, grub or corbie in turf | 450 | 1 | – | **Not supported** | **Not supported** | 28 g ac/ha |
| Control of other insect pests in turf | 350 | 2 | – | **Not supported** | **Not supported** | 28 g ac/ha |
| Termite protection | 100000 | 1 | – | Negligible exposure | Negligible exposure | n/a |
| Subterrannean clover, clover, lucerne | 400 | 2 | 7 | **Not supported** | **Not supported** | 28 g ac/ha |
| Field tomatoes | 250 | 2 | 7 | **Not supported** | **Not supported** | 28 g ac/ha |

Maximum seasonal supported rate considers both dietary exposure scenario (see Appendix A) and food chain assessment scenario (seasonal catchment exposure rates from Table B1 in Appendix B were compared to maximum acceptable of 76 g ac/ha).

Table 29: Screening level assessment of acute risks to birds ingesting granules with/as grit (grapevine rootlings)

| Parameter | | Small bird | Large bird |
| --- | --- | --- | --- |
| Application rate | (kg granules/ha) | 80 | 80 |
| Active constituent content | (mg ac/kg granules) | 100,000 | 100,000 |
| Granular density | (granules/kg) | 1,500,000 | 1,500,000 |
| Gloading | (mg ac/granule) | 0.067 | 0.067 |
| Gsurface | (granules/m2) | 12,000 | 12,000 |
| SPsurface | (no. soil particles/m2) | 15,200 | 71 |
| DGritI | (grit/kg bw/d) | 651 | 2,453 |
| DgritD | (mg ac/kg bw/d) | 19 | 163 |
| RAL | (mg ac/kg bw/d) | 3.2 | 3.2 |
| RQ | (unitless) | 6.0 | 51 |

Assessment method according to EFSA (2009)

Application rate based on 20 g/vine for product no. 50416 and assumes 4000 vines/ha

Gloading = active constituent content (mg acs/kg granules)/granular density (granules/kg)

Gsurface = number of granules on soil surface per m2 = application rate (kg granules/ha) \* granular density (granules/kg) /10000

SPsurface = number of soil particles from EFSA (2009)

DgritI = daily grit intake from EFSA (2009)

RAL = regulatory acceptable level (from Table 27)

DgritD = daily grit dose (mg ac/kg bw/d) = DgritI \* (Gsurface/(SPsurface + Gsurface)) \* Gloading

RQ = risk quotient = DgritD/RAL, where acceptable RQ ≤1

Table 30: Screening level assessment of acute risks of seed treatments to birds at lowest treatment rate of 400 mg ac/kg seed

| Food item | Indicator species | Shortcut  value | NAR (mg ac/kg seed) | DDD (mg ac/kg bw) | RAL (mg ac/kg bw) | RQ |
| --- | --- | --- | --- | --- | --- | --- |
| Treated seed | Small granivorous bird | 0.30 | 400 | 120 | 3.2 | **38** |
| Newly emerged shoots | Small omnivorous bird | 0.50 | 400 | 40 | 3.2 | **13** |

Shortcut values (FIR/bw) from EFSA (2009) for avian exposure to small seeds and newly emerged shoots

NAR = nominal application rate (lowest registered rate)

Consumption of treated seed DDD = daily dietary dose (mg/kg bw/d) = shortcut value \* NAR (mg/kg)

Consumption of newly emerged shoots DDD = daily dietary dose (mg/kg bw/d) = shortcut value \* NAR (mg/kg)/5

RAL = regulatory acceptable level (Table 27)

RQ = risk quotient = DDD/RAD, where acceptable RQ ≤1

Table 31: Assessment of acute risks of insect baits to birds at lowest treatment rate of 50 mg ac/kg bait

| Focal group | Indicator species | BW (g) | DEE (kJ/d) | FIR (g/d) | DDD (mg ac/kg bw) | RAL (mg ac/kg bw) | RQ |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Omnivorous birds | Lark (P) | 23 | 90 | 8.1 | 18 | 3.2 | 5.5 |
| Pipit | 26 | 97 | 8.8 | 17 | 3.2 | 5.3 |
| Magpie (P) | 300 | 509 | 46 | 7.7 | 3.2 | 2.4 |
| Raven (P) | 530 | 747 | 68 | 6.4 | 3.2 | 2.0 |
| Gull | 288 | 305 | 27 | 4.7 | 3.2 | 1.5 |
| Duck | 823 | 616 | 54 | 3.3 | 3.2 | 1.0 |
| Bustard | 4500 | 1919 | 167 | 1.9 | 3.2 | 0.58 |
| Granivorous birds | Finch (P) | 12 | 58 | 5.2 | 22 | 3.2 | 6.8 |
| Dove | 33 | 72 | 6.2 | 9.3 | 3.2 | 2.9 |
| Quail | 105 | 155 | 15 | 7.2 | 3.2 | 2.3 |
| Parrot | 90 | 140 | 12 | 6.8 | 3.2 | 2.1 |
| Pigeon | 207 | 245 | 21 | 5.1 | 3.2 | 1.6 |

BW = body weight

DEE = daily energy expenditure (calculated using DEE equation for passerine (P) or non-passerine birds, EFSA 2009 p269)

FIR = DEE/(FE \* (1-MC/100) \* (AE/100)), where:

FE = food energy of 18 kJ/g dw for cereals on average (Table 3 in Appendix G in EFSA 2009)

MC = moisture content of 15% for cereals on average (Table 3 in Appendix G in EFSA 2009)

AE = assimilation efficiency (Table 2 in Appendix L of EFSA 2009), which is:

72% for passerines on artificial diet (lark, pipit, magpie, raven, finch)

74% for Charadriiformes and Anseriformes on artificial diet from Table 2 in Appendix L in EFSA 2009 (gull, duck)

67% for Galliformes on artificial diet from Table 2 in Appendix L in EFSA 2009 (quail)

76% for Columbiformes on artificial diet from Table 2 in Appendix L in EFSA 2009 (dove, pigeon)

75% default for remaining species (bustard, parrot)

DDD = daily dietary exposure = FIR/BW \* PEC, where:

PEC =predicted environmental concentration = concentration of the active constituent in the bait = 50 mg ac/kg food

RAL = regulatory acceptable level (Table 27)

RQ = risk quotient = DDD/RAL, where acceptable RQ ≤1

Table 32: Food chain assessment in terrestrial vertebrates (maximum acceptable threshold)

| Exposure | Indicator species | Group | Shortcut | PECmedia  (mg/kg or mg/L) | DDD  (mg/kg/d) | RAL  (mg/kg/d) | RQ |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Chronic | Earthworm-eating species | Mammals | 1.28 | 0.10 | 1.0 | 1.0 | 1.0 |
|  |  | Birds | 1.05 | 0.10 | 1.1 | 2.9 | 0.40 |
|  | Fish-eating species | Mammals | 0.142 | 0.0001 | 0.020 | 1.0 | 0.02 |
|  |  | Birds | 0.159 | 0.0001 | 0.022 | 2.9 | 0.01 |

Shortcut value from EFSA (2009)

PECmedium is:

PECsoil = predicted environmental concentration in soil (mg/kg) = 76 g ac/ha (maximum acceptable seasonal rate to achieve RQ 1.0)/750

PECwater = aquatic RAL (from Table 27)

PECfood = PECmedium \* BCF, where:

BCFearthworm is 8.8 based on [0.84 + 0.012 \* 10^(log Kow of 4.9)]/Kd 108 (for 2% OC; from Table 25)

BCFfish is 1374 (Murphy & Luteske 1986)

DDD = daily dietary dose (mg/kg bw/d) = shortcut value \* PECfood

RAL = regulatory acceptable level (from Table 27)

RQ = risk quotient = PEC/RAL, where acceptable RQ ≤1)

Aquatic species

The application rate for polluted water impoundments is predicted to result in water concentrations that exceed the aquatic endpoint. The application rate of 2 mL/10000 L, or 20 mL/100 m3 water results in a water concentration of 100 µg ac/L, which is 3 orders of magnitude higher than the aquatic endpoint (risk quotient = 1,000). However, the actual aquatic risk is dependent on the purpose of the water impoundment (including dams or those found in urban areas such as ditches, sewage ponds and drains). Therefore, it is recommended that existing environmental protection statements on labels be expanded to include directions to limit use for control of mosquito larvae to temporary pools, as opposed to permanent water bodies, which are more likely to contain sensitive aquatic species. The following restraint is therefore required for any products used to control mosquito larvae in polluted water impoundments.

DO NOT use on permanent water bodies for control of mosquito larvae.

Runoff risks to aquatic species for most of the remaining uses are acceptable with the exception of grapevine rootlings and external perimeter treatment for termite protection (Table 33). Assessment details are provided in Appendix D.

A further scenario for termite control is treatment of termite nests or colonies. If such treatment is protected from runoff losses, this use is supportable. However, outdoor treatments including in trees are not supported due to a general lack of information required to support exposure calculations.

Of the acceptable scenarios for runoff, only potted ornamentals, Tasmanian blue gum soil, oilseeds (up to 110 g ac/ha), and non-crop uses have been supported by the terrestrial vertebrate assessment. The following runoff restraint is required for these uses.

DO NOT apply if heavy rains or storms are forecast within 3 days.

Table 33: Chlorpyrifos – Summary of runoff risk assessment outcomes for agricultural uses

| Situation | Rate  (g ac/ha) | Number | Interval  (d) | Conclusion |
| --- | --- | --- | --- | --- |
| Pasture, lucerne, sugarcane, forage crops, oilseeds (excluding cotton and canola) | 350 | 2 | 7 | Acceptable risk |
| Duboisia, ginger | 450 | 1 | – | Acceptable risk |
| Tree and vine crops | 250 | 1 | – | Acceptable risk |
| Grapevine rootlings | 8,000 | 1 | – | Not supported |
| Vegetable crops (band application) | 400 | 2 | 7 | Acceptable risk |
| Vegetable crops (broadcast application) | 350 | 2 | 7 | Acceptable risk |
| Potted ornamentals and Tasmanian blue gum planting hole soil | 5,000 | 1 | – | Acceptable risk |
| External perimeter treatment for control of crawling insects around large buildings | 5,000 | 1 | – | Acceptable risk |
| Control of adult mosquitos in vegetation | 54 | 4 | 7 | Acceptable risk |
| Commercial turf (farms) | 500 | 2 | 7 | Acceptable risk |
| External perimeter treatment (horizontal or vertical) around large buildings for termite protection | 1,000,000 | 1 | – | Not supported |
| 500,000 | 1 | – | Not supported |
| New and existing poles for termite protection | 1,000,000 | 1 | – | Acceptable risk |
| Subterrannean clover, clover, lucerne | 400 | 2 | 7 | Acceptable risk |
| Field tomatoes | 250 | 2 | 7 | Acceptable risk |

### Bees

Exposure of bees is expected to be negligible for soil drenches, granular products, termite protection and crawling insect control. Therefore, risks to bees are acceptable for these use patterns.

Risks to bees foraging in other treated areas are assessed using a tiered approach. A screening level risk assessment assumes the worst-case scenario of a direct overspray of blooming plants that are frequented by bees in order to identify those substances and associated uses that do not pose a risk. Acceptable risks to foraging bees cannot be concluded at the lowest rate of 54 g ac/ha. No higher tier information is available to inform an acceptable aging period for foliar residues. The following protection statement is advised for spray applications of chlorpyrifos.

Highly toxic to bees. To protect bees and pollinating insects, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.

Table 34: Screening level assessment of risks to bees

| Life stage | Exposure | Rate (g/ha) | Predicted total dose (µg/bee) | RAL (µg/bee) | RQ |
| --- | --- | --- | --- | --- | --- |
| Highest maximum single rate | | | | | |
| Adults | Acute contact | 500 | 1.2 | 0.030 | **40** |
| Acute oral | 500 | 14 | 0.084 | **170** |
| Larvae | Acute oral | 500 | 6.1 | 0.0084 | **721** |
| Lowest maximum single rate | | | | | |
| Adults | Acute contact | 54 | 0.13 | 0.030 | **4.3** |
| Acute oral | 54 | 1.5 | 0.084 | **18** |
| Larvae | Acute oral | 54 | 0.65 | 0.0084 | **78** |

Highest maximum single is 500 g ac/ha in spot application in avocado and turf (noting up to 5000 g ac/ha possible in ornamentals)

Lowest maximum single rate is 54 g ac/h for mosquito control

Predicted total dose calculated using US EPA BeeREX tool for adult worker bee foraging for nectar and larval drone within the hive

RAL = regulatory acceptable level (from Table 27)

RQ = risk quotient = PEC/RAL, where acceptable RQ ≤1

### Other non-target arthropods

Based on available data, chlorpyrifos products are not considered to be compatible with integrated pest management programs utilising beneficial arthropods. Therefore, the following protection statement is advised for use of chlorpyrifos in crops.

Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas.

### Soil organisms

Risks to soil organisms are assessed using a tiered approach. A screening level risk assessment assumes the worst-case scenario of a direct overspray of soil without interception in order to identify those substances and associated uses that do not pose a risk to soil organisms. Acceptable risks of chlorpyrifos to soil organisms could be concluded at the screening level up to 5000 g ac/ha (surface spray in potted ornamentals). Use in grapevine rootlings is not supported. No protection statements are required for soil organisms on chlorpyrifos product labels with the supported uses.

Table 35: Screening level assessment of risks to soil organisms

| Group | Exposure | Rate (g/ha) | PEC (mg/kg dry soil) | RAL (mg/kg dry soil) | RQ |
| --- | --- | --- | --- | --- | --- |
| Grapevine rootlings | | | | | |
| Macro-organisms | Acute | 8000 | 11 | 7.6 | 1.4 |
| Chronic | 8000 | 11 | 6.4 | 1.7 |
| Micro-organisms | Chronic | 8000 | 11 | 6.4 | 1.7 |
| Potted ornamentals (surface spray) | | | | | |
| Macro-organisms | Acute | 5000 | 6.7 | 7.6 | 0.88 |
| Chronic | 5000 | 6.7 | 6.4 | 1.0 |
| Micro-organisms | Chronic | 5000 | 6.7 | 6.4 | 1.0 |

PEC = predicted environmental concentration in top 5-cm soil (mg ac/kg dry soil) = rate (g ac/ha)/750

RAL = regulatory acceptable level (from Table 27)

RQ = risk quotient = PEC/RAC, where acceptable RQ ≤1

### Terrestrial plants

Chlorpyrifos is not toxic to non-target terrestrial plants and buffer zones are not required for the protection of vegetation areas.

## Environment recommendations

Uses supported from the viewpoint of environmental safety are listed in Table 36 with the required protection statements and restraints. Uses that are not supported from the viewpoint of environmental safety are listed in Table 37.

Table 36: Supported uses from the viewpoint of environmental safety

| Situation | Protection statements and restraints |
| --- | --- |
| All situations | Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. |
| Ear tags, banana bags, hides/skins, termite nest or colony in wall cavities | (No additional protection statements or restraints are required) |
| Control of mosquito larvae in temporary water pools | DO NOT use on permanent water bodies for control of mosquito larvae. |
| Ornamental potting soil and Tasmanian blue gum planting soil | Toxic to birds and wild mammals. To protect birds and wild mammals, the product must be entirely incorporated into the soil. Remove spillages. |
| Potted ornamentals (soil drench) | DO NOT apply if heavy rains or storms are forecast within 3 days. |
| Potted ornamentals (surface spray) | DO NOT apply if heavy rains or storms are forecast within 3 days. |
|  | Highly toxic to bees. To protect bees and pollinating insects when controlling Argentine ants in container plants, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray. |
| Crawling insects in and around buildings | DO NOT apply if heavy rains or storms are forecast within 3 days. |
|  | Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees. |
| Ant nests and trails | Toxic to birds and wild mammals. DO NOT use in areas easily accessible to birds and wild mammals. To protect birds and wild mammals, remove spillages. |
|  | Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees. |
| Spot spray to funnel ant mounds in commercial turf | Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees. |
| Chemical barrier (horizontal or vertical) under structures for termite protection | To avoid runoff from under-slab termite treatments, the moisture membrane must be installed immediately after treatment. |
| Treatment of new and existing poles for termite protection |
| Oilseeds (excluding cotton and canola) up to 110 g ac/ha per season | Toxic to beneficial arthropods. Not compatible with integrated pest management (IPM) programs utilising beneficial arthropods. Minimise spray drift to reduce harmful effects on beneficial arthropods in non-crop areas. |
|  | Toxic to birds and wild mammals. However, the use of this product as directed is not expected to have adverse effects on birds and wild mammals. |
|  | DO NOT apply if heavy rains or storms are forecast within 3 days. |
|  | Highly toxic to bees. To protect bees and pollinating insects when controlling Argentine ants in container plants, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray. |

Table 37: Uses not supported from the viewpoint of environmental safety

| Situation | Basis |
| --- | --- |
| Control of adult mosquitos in vegetation | Unacceptable risk to terrestrial vertebrates |
| Oilseeds (excluding cotton and canola) greater than 110 g ac/ha, Pasture, lucerne, sugarcane, forage crops, Duboisia |  |
| Grapevines, avocado, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards |  |
| Vegetables (band or broadcast applications), ginger |  |
| Seed dressings |  |
| Insect baits |  |
| Commercial turf (excluding spot spray application to funnel ant mounds in commercial turf) |  |
| Combination products (subterrannean clover, clover, lucerne, field tomatoes) |  |
| Grapevine rootlings | Unacceptable risk to terrestrial vertebrates, aquatic species, and soil organisms |
| Control of mosquito larvae in permanent water bodies | Unacceptable risk to aquatic species |
| External perimeter treatment (horizontal or vertical) around large buildings for termite protection |  |
| Outdoor termite nests or colonies (including trees) |

# Efficacy and target safety

## Efficacy

The label variations recommended in this Technical Report are within the currently approved use patterns. The use of the products, when used according to label directions, is expected to meet the efficacy criteria as described in the Agricultural and Veterinary Chemicals Code (Efficacy Criteria) Determination 2014 based on previous assessments and a demonstrated history of effective use.

## Target crop safety

The label variations recommended in this Technical Report are within existing use patterns. Based on the previous satisfaction that the uses would be safe to target crops and that the APVMA has not received any adverse experience reports in relation to in-crop damage or off target damage from chlorpyrifos products, the APVMA is satisfied that the products will meet the safety criteria as they relate to target crop safety when used according to the proposed labels.

## Target animal safety

The label variations recommended in this Technical Report are within the existing use patterns. The APVMA has received no adverse experience reports on animals that were considered likely to be caused by a chlorpyrifos product used according to label directions. Accordingly, the APVMA is satisfied that the products meet the safety criteria as they relate to target animal safety when chlorpyrifos products are used according to the proposed labels.

# Spray drift

The APVMA’s approach to spray drift management set out in the [APVMA Spray Drift Policy July 2019](https://apvma.gov.au/node/10796) specifies consideration of spray drift in bystander areas, livestock areas, natural aquatic areas, pollinator areas and vegetation areas. The regulatory acceptable levels (RALs) for each area are summarised in Table 38, which is the maximum amount of spray drift exposure that is not expected to cause undue harm to sensitive areas.

Table 38: Regulatory acceptable levels of chlorpyrifos resulting from spray drift

| Area considered | Regulatory acceptable level |
| --- | --- |
| Natural aquatic areas | 0.10 µg ac/L |
| Pollinator areas | 12 g ac/ha |
| Vegetation areas | 1200 g ac/ha |
| Bystander areas | 3.87 g ac/ha |
| Livestock areas | 0.75 mg/kg |

The APVMA has only considered spray drift implications for uses of chlorpyrifos that are supported by the worker health and safety, residues, trade and environment risk assessments. These uses include:

* banana bags
* cattle ear tags
* insect control in agricultural, commercial and industrial areas, commercial turf, container plants, hides/skins and potted ornamentals using manually pressurised handwand application equipment
* treatment of termite nest or colony in wall cavities using manually pressurised handwand application equipment.

In accordance with the APVMA Spray Drift Policy July 2019, mandatory downwind buffer zones are not required for backpack/knapsack or low and high-pressure handwand application methods. Spray drift requirements are also not relevant to products formulated as solid slow-release generators, such as banana bags and ear tag products. Therefore, no spray drift restraints are required for uses of chlorpyrifos supported by the worker health and safety, residues, trade and environment risk assessments.



Appendices

Appendix A – Summary of assessment outcomes

Table 39: Chlorpyrifos uses that are supported by all risk assessments

| Crop/host | | Pest | | Rate | Amended instructions for use1 |
| --- | --- | --- | --- | --- | --- |
| Horticultural uses | | | | | |
| Banana | Sugarcane bud moth, banana rust thrips, banana scab moth | | One bag/bunch  *(0.45 g ac/bunch)* | | Protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.  Safety directions for chlorpyrifos SR impregnated plastic film 10 g/kg or less (Table 12). |
| Veterinary uses | | | | | |
| Ear tags of beef cattle | Buffalo flies *(Haematobia irritans exigua)*  Cattle lice *(Bovicola bovis, Linognathus vituli, Haematopinus eurysternus, Solenoptes capillatus)* | | One tag/animal  *(1.5 g ac/animal)* | | Trade advice statement: EXPORT SLAUGHTER INTERVAL (ESI): DO NOT administer this ear tag product less than 28 days before slaughter for export. Before using this product, confirm the current ESI from Before using this product, confirm the current ESI from Landmark Operations Limited on 1800 448 892 or the APVMA website (apvma.gov.au/residues).  Environmental protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.  First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos as set out in Table 11). |
| Miscellaneous uses | | | | | |
| Agricultural, commercial and industrial areas (not publicly accessible) | Ants (including Argentine ants)  Fleas | | 4.5 g ac/L water to 5 g ac/L water | | **Restraint:** DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.  **Protection statement:** Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.DO NOT apply if heavy rains or storms are forecast within 3 days. Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees.  **First aid instructions and warnings** for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11).  **Safety directions** for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14 or chlorpyrifos EC 700 g/L (or less) in Table 15). |
| Container plants in soil or other growing media (commercial) | Argentine ants | | 5 g ac/L water | | Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.  Protection statement:  Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers DO NOT apply if heavy rains or storms are forecast within 3 days. Highly toxic to bees. To protect bees and pollinating insects when controlling Argentine ants in container plants, DO NOT apply when flowering plants or weeds are present. DO NOT use where bees are actively foraging. Before spraying, notify beekeepers to move hives to a safe location with an untreated source of nectar and pollen, if there is potential for managed hives to be affected by the spray.  First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos as set out in Table 11).  Safety directions for relevant product formulation (i.e. chlorpyrifos WP 500 g/kg (or less) in Table 16 or chlorpyrifos WG 750 g/kg (or less) in Table 17). |
| Hides/skins | Hide beetles | | 1 g ac/L water *(minimum 15 g ac/skin)* | | Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.  Protection statement: Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.  First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11).  Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14 or chlorpyrifos EC 700 g/L (or less) in Table 15). |
| Potted ornamentals (commercial) | Scarab beetles – larvae | | 0.1 – 0.2 g ac/L water | | Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.  Protection statement:  Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. DO NOT apply if heavy rains or storms are forecast within 3 days.  First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11).  Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14). |
| Treatment of termite nest or colony (in wall cavities) | Termites | | 5 g ac/L water | | Restraint: DO NOT apply using equipment carried on the back of the user. DO NOT apply using mechanically pressurized hand wand sprayer.  Protection statement:  Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.  First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11).  Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14). |
| Turf (Commercial) | Funnel ant | | 2.5 g ac/5L water or 0.015 g ac/per mound (spot spray) | | Withholding period: DO NOT graze treated turf or lawn; or feed turf or lawn clippings from any treated area to poultry or livestock  Protection statement:  Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers. Highly toxic to bees. However, the use of this product as directed is not expected to have adverse effects on bees.  First aid instructions and warnings for relevant product formulation (i.e. >5% chlorpyrifos and > 25% liquid hydrocarbons as set out in Table 11).  Safety directions for relevant product formulation (i.e. chlorpyrifos EC 500 g/L (or less) in Table 14). |

1 All instructions for use on labels of agricultural chemical products and veterinary chemical products should align with requirements set out in the [Agricultural Labelling Code](https://apvma.gov.au/node/934) and [Veterinary Labelling Code](https://apvma.gov.au/taxonomy/term/18346) respectively.

Table 40: Chlorpyrifos uses that are not supported due to safety and/or trade concerns

| Crop/host | Pest | Rate | Assessment outcome1 |
| --- | --- | --- | --- |
| Fruit and vegetables | | | |
| Apples, pears | Woolly aphid, mealybug, apple dimpling bug | 750 – 1,000 g ac/ha  *(50 g ac/100 L water applied using 1,500 – 2,000 L water/ha)* | Not supported – safety (residues and worker exposure) and trade concerns. |
| San Jose’ scale | 750 – 1,000 g ac/ha  *(50 g ac/100 L water applied using 1,500 – 2,000 L water/ha, seasonal period)* | Not supported – safety (residues and worker exposure) and trade concerns. |
| 250 g ac/ha  *(50 g ac/100 L water applied using 500 L water/ha, 2% miscible winter oil may be added in dormant period)* | Not supported – safety (environment) concerns. |
| Light brown apple moth | 375 – 500 g ac/ha  *(25 g ac/100 L water applied using 1,500 – 2,000 L water/ha)* | Not supported – safety (worker exposure) and trade concerns. |
| Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – trade concerns. |
| Queensland fruit fly | 0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha  *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)* | Not supported – safety (worker exposure) and trade concerns. |
| Avocado | Fiorinia scale, latania scale | 1,000 g ac/ha  *(50 g ac/100 L water applied using 2,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Hairy caterpillar, latania scale, light brown apple moth, red shouldered leaf beetle | 1,000 g ac/ha  *(50 g ac/100 L, spot spray)* | Not supported – safety (worker exposure) concerns. |
| Hairy caterpillar, latania scale, light brown apple moth, red shouldered leaf beetle | 500 g ac/ha  *(25 g ac/100 L, spot spray)* | Not supported – safety (environment) concerns. |
| Avocado leafroller, ivy leafroller | 500 g ac/ha or 1,000 g ac/ha + 500 g ac/ha dichlorvos  *(25 or 50 g ac/100 L + 250 g ac/100 L dichlorvos)* | Not supported – safety (environment and worker exposure) concerns. |
| Ivy leafroller | 500 or 1,000 g ac/ha  *(25 or 50 g ac/100 L)* | Not supported – safety (environment and worker exposure) concerns. |
| Queensland fruit fly | 0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha  *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)* | Not supported – safety (worker exposure) concerns. |
| Banana | Banana scab moth, banana flower thrips | 500 g ac/ha to 1,000 g ac/ha  *(Aerial – minimum 10 L water; Airblast – 100 g ac/100 L water applied at 500 L water/ha to 1,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Banana scab moth | 5 g ac/5 L *(knapsack)* | Not supported – safety (worker exposure) concerns. |
| Caterpillars, lepidopterous caterpillars | 500 g ac/ha to 1,000 g ac/ha  *(100 g ac/100 L water applied at 500 L water/ha to 1,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Cluster caterpillars | 75 to 100 g ac/ha *(spot spray)* | Not supported – safety (worker exposure) concerns. |
| Banana weevil borer | 500 to 900 g ac/ 100 L water or 2.5 to 3.5 g ac/stool | Not supported – safety (worker exposure) concerns. |
| 250 g ac/100 L water or 250 g ac/4 kg sand | Not supported – safety (worker exposure) concerns. |
| Beetroot | Earwigs | 350 g ac/ha  *(35 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (residues) concerns. |
| Beetroot, carrots, cassava, radishes, sweet potato, turnips | Cutworm | 350 g ac/ha  *(35 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Beetroot, carrots, parsnip, radishes, sweet potato, turnips | Vegetable weevil | 400 g ac/ha | Not supported – safety (environment and residues) concerns. |
| Beetroot, carrots, radishes, sweet potato, turnips | Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns, based on pest activity in relevant crop growth stages. |
| Beetroot, carrots, radish, shallots, turnips, onions | Cutworms, earwigs, false wireworms, field crickets, harvester ants, mole crickets | 250 g ac/10 kg seed | Not supported – safety (environment and worker exposure) concerns. |
| Capsicum, eggplant | Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Carrots | Light brown apple moth | 250 – 350 g ac/ha | Not supported – safety (environment and residues) concerns. |
| Cabbage, cauliflower | African black beetle | 1,000 g ac/ha | Not supported – safety (worker exposure) concerns. |
| 150 g ac/100 L water *(drench at 100 mL/plant)* | Not supported – safety (worker exposure) concerns. |
| Chard (silver beet) | Vegetable weevil | 400 g ac/ha | Not supported – safety (environment and residues) concerns. |
| Citrus fruits | California red scale (Citrus red scale) | 1,000 – 2,000 g ac/ha  *(25 – 50 g ac/100 L water applied using 4,000 L water/ha)* | Not supported – safety (environment and worker exposure) and trade concerns. |
| Citrus rust thrips, citrus leaf eating weevil, citrus mealy bug, fruit eating weevil, fullers rose weevil, purple scale, white louse scale | 2,000 g ac/ha  *(50 g ac/100 L water applied using 4,000 L water/ha)* | Not supported – safety (environment and worker exposure) and trade concerns. |
| Ants | 1,000 g ac/ha  *(or 100 gac/100 L water applied at 1.5 L spray per butt)* | Not supported – safety (environment and worker exposure) and trade concerns. |
| 1,000 g ac/100 L water | Not supported – safety (environment and worker exposure) and trade concerns. |
| Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – trade concerns. |
| Queensland fruit fly | 0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha  *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)* | Not supported – safety (worker exposure) and trade concerns. |
| Cole (brassica) crops (including broccoli, brussels sprouts, cabbage, cauliflower) | Cabbage moth, cabbage white butterfly, cabbage aphid, cluster caterpillar, cabbage cluster caterpillar, butterflies | 750 or 1,000 g ac/ha  *(75 – 100 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (residues, environment and worker exposure) concerns. |
| Helicoverpa spp (including corn earworm, native budworm) | 750 or 1,000 g ac/ha  *(75 – 100 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (residues, environment and worker exposure) concerns. |
| Vegetable weevil | 500 g ac/ha | Not supported – safety (worker exposure) concerns. |
| 400 g ac/ha | Not supported – safety (environment) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages. |
| African black beetle | 350 – 450 g ac/ha | Not supported – use is not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages. |
| Red earth mite, blue oat mite | 70 or 150 g ac/ha | Not supported – safety (environment) concerns. |
| Cucumbers | Ants, mealybugs | 500 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Wingless grasshopper, white flies | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Cucurbit vegetables or cucurbits (excluding cucumbers) | Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment and residues) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment and residues) concerns. |
| Vegetable weevil | 400 g ac/ha | Not supported – safety (environment and residues) concerns. |
| White flies | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (residues) concerns. |
| Ants, mealybugs | 500 g ac/ha | Not supported – safety (residues and worker exposure) concerns. |
| Custard apple | Ants | 1,000 g ac/ha to 10,000g ac/ha  *(100 g ac/100 L water to 1,000 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Ginger | African black beetle, cutworm | 350 – 450 g ac/ha  *(35 – 45 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Grapes (grape vines) | Light brown apple moth, grapevine moth | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – trade concerns. |
| Grapevine scale | 250 g ac/ha or 125 gac/ha + 5 L miscible winder oil  *(50 g ac/100 L water or 25 g ac + 1 L miscible winter oil/100 L water applied using 500 L water/ha, dormant period)* | Not supported – safety (environment) concerns. |
| Mealybug, tuber mealybug | 500 g ac/ha  *(50 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (worker exposure) and trade concerns. |
| Green beans, peas | Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Wingless grasshopper, white flies | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Kiwifruit | Common and southern armyworms, light brown apple moth, scale insects | 500 g ac/ha  *(25 g ac/100 L water, applied using 2,000 L water/ha)* | Not supported – safety (worker exposure) concerns. |
| Leafy crucifers including chou moullier, kale, mustard, rape | Vegetable weevil | 500 g ac/ha | Not supported – safety (residues and worker exposure) concerns. |
| 400 g ac/ha | Not supported – safety (residues) concerns. |
| Redlegged earth mite blue oat mite | 70 – 150 g ac/ha | Not supported – safety (residues) concerns. |
| Lettuce | Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Lettuce and chard (silver beet) | Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Redlegged earth mite, blue oat mite | 70 or 150 g ac/ha | Not supported – safety (environment) concerns. |
| Loquats | Queensland fruit fly | 0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha  *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)* | Not supported – safety (worker exposure) concerns. |
| Mango | Green tree ant | 1,000 g ac/ha  *(50 g ac/100 L water applied using 2,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Common mango scale | 2,000 g ac/ha  *(100 g ac/100 L water applied using 2,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Onions, shallots | Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages. |
| Passionfruit | Queensland fruit fly | 60 g ac/ha  *(200 g ac/100 L water applied using 30 L/ha)* | Not supported – safety (worker exposure) concerns. |
| Pineapples | White grubs | 2,500 g ac/ha (pre-plant, soil-incorporated) | Not supported – safety (worker exposure) concerns. |
| Pineapple scale | 1,500 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Pineapple mealybug, ants | 750 or 1,500 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Pome fruits | Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – trade concerns. |
| Queensland fruit fly | 0.1 – 0.2 g ac/tree or 30 – 60 g ac/ha  *(200 g ac/100 L water applied using 50 – 100 mL/tree or 15 – 30 L/ha)* | Not supported – safety (worker exposure) and trade concerns. |
| Potatoes | Wireworm | 3,000 g ac/ha | Not supported – safety (worker exposure) concerns. |
| African black beetle | 1,500 – 3,000 g ac/ha | Not supported – safety (worker exposure) concerns. |
| 450 – 500 g ac/ha | Not supported – safety (worker exposure) concerns. |
| White fringed weevil | 3,000 g ac/ha | Not supported – safety (worker exposure) concerns. |
| 450 – 500 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns; use also not considered practical with the application timing restriction required to mitigate safety (residues) concerns based on pest activity in relevant crop growth stages. |
| Stalk and stem vegetables (including asparagus, celery and rhubarb) | Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Cutworm | 350 g ac/ha  *(35 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Stone fruits | European earwig | 750 – 1,000 g ac/ha  *(50 g ac/100 L water applied using 1,500 – 2,000 L water/ha)* | Not supported – safety (worker exposure) and trade concerns.  *Peaches:* Not supported – safety (residues and worker exposure) and trade concerns. |
| 100 g ac/ha  *(with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)* | Not supported – safety (environment and worker exposure) and trade concerns. |
| San Jose’ scale | 750 g ac/ha  *(50 g ac/100 L water applied using 1,500 L water/ha, seasonal period)* | Not supported – safety (worker exposure) and trade concerns.  *Peaches:* Not supported – safety (residues, environment and worker exposure) and trade concerns. |
| 250 g ac/ha  *(50 g ac/100 L water applied using 500 L water/ha, 2% miscible winter oil may be added, dormant period)* | Not supported – safety (environment) concerns. |
| Light brown apple moth | 375 g ac/ha  *(25 g ac/100 L water applied using 1,500 L water/ha)* | Not supported – safety (worker exposure) and trade concerns.  *Peaches:* Not supported – safety (residues and worker exposure) and trade concerns. |
| 0.0125 – 0.025 g ac/tree  *(25 g ac/100 L water applied using 50 – 100 mL/tree)* | Not supported – trade concerns. |
| Queensland fruit fly | 0.1 – 0.2 g ac/tree  *(200 g ac/100 L water applied using 50 – 100 mL/tree)* | Not supported – safety (worker exposure) and trade concerns. |
| Strawberry | Field cricket, mole cricket | 50 g ac/ha *(in 10 kg bran bait)* | Not supported – safety (environment and worker exposure) concerns. |
| Swede, turnip | Vegetable weevil | 350 – 500 g ac/ha  *(35 – 50 g ac/100 L water – 50 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (residues and worker exposure) concerns. |
| Redlegged earth mite, blue oat mite | 70 – 150 g ac/ha | Not supported – safety (residues) concerns. |
| Tomatoes | False wireworm, wireworm | 2,500 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Whitefly *(Trialeurodesvaporariorum)* | 1,500 g ac/ha  *(60 g ac/100 L water applies using 2,500 L water)* | Not supported – safety (environment and worker exposure) concerns. |
| African black beetle | 1,000 g ac/ha | Not supported – safety (worker exposure) concerns. |
| 150 g ac/100 L water *(drench at 100 mL/plant)* | Not supported – safety (worker exposure) concerns. |
| Silverleaf whitefly | 1,500 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| 750 – 1,000 g ac/ha  *(75 – 100 g ac/100 L water – 100 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Green vegetable bug, *Helicoverpa* spp. (including tomato grub, native budworm) | 750 to/or 1,000 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Green peach aphid | 500 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Vegetable weevil | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Cutworm, false wireworm | 350 g ac/ha  *(35 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Wingless grasshopper | 250 g ac/ha  *(25 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (environment) concerns. |
| Vegetables (various) | Field cricket, mole cricket | 50 g ac/ha *(in 10 kg bran bait)* | Not supported – safety (environment and worker exposure) concerns. |
| Field crops and pasture | | | |
| Barley, wheat | Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea | 100 to 200 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Blue oat mite, pasture webworm | 200 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Bryobia Mite | 400 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Barley, wheat, oats, rye, triticale | Redlegged earth mite, blue oat mite | 70 to 150 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Canola (rapeseed) | False wireworm, wireworms | 500 or 750 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Balaustium mite | 400 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Cutworms | 350 to 450 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Bryobia mite | 400 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Vegetable weevil | 200 to 400 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Wingless grasshopper | 250 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Blue oat mite, pasture webworm | 200 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea | 100 to 200 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Redlegged earth mite, blue oat mite | 70 to 150 g ac/ha (ground spray) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Lucerne flea | 70 to 150 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| 35 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Redlegged earth mite | 70 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| False wireworms | 125 g ac/310 kg seed | Not supported – safety (environment and worker exposure) concerns. |
| Cereals | Spur throated locust | 625 to 750 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Blackheaded pasture cockchafer | 450 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Southern armyworm, common armyworm | 350 to 450 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Cutworm | 350 or 450 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Pasture webworm | 350 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| 150 g ac/ha (post emergence) | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| 150 g ac/ha (pre-plant) | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Australian plague locust | 280 or 175 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Wingless grasshopper | 250 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Migratory locust | 175 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Redlegged earth mite, blue oat mite | 35 or 70 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Lucerne flea | 35 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Black soil scarab, wheat root scarab | 250 g ac/125 kg seed or  250 g ac/10 kg seed | Not supported – safety (environment and worker exposure) and trade concerns. |
| Spine-tailed weevil | 125 g ac/210 kg seed | Not supported – safety (environment and worker exposure) and trade concerns. |
| False wireworms, wireworms | 125 g ac/310 kg seed | Not supported – safety (environment and worker exposure) and trade concerns. |
| Cereal curculio | 125 g ac/210 kg seed or  60 g ac/100 kg seed | Not supported – safety (environment and worker exposure) and trade concerns. |
| Spotted vegetable weevil | 125 g ac/210 kg seed | Not supported – safety (environment and worker exposure) and trade concerns. |
| Seed harvesting ants | 40 g ac/100 kg seed | Not supported – safety (environment and worker exposure) and trade concerns. |
| Coffee beans (non-bearing) | Mealybugs | 1,000 g ac/ha  *(butt and soil treatment applied at 100 g ac/100 L water using 1,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Cotton | Spur throated locusts | 625 g or 750 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Cotton flea beetle, red shouldered leaf beetle | 450 or 750 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Mites | 750 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| 300 to 450 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Pink spotted bollworm moth (Pectinophora scutigera) | 500 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Cutworm | 350 or 450 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Southern armyworm, common armyworm | 350 or 450 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Wingless grasshopper | 250 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Cotton aphid | 150 or 200 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Migratory locusts | 175 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Springtails | 150 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Blue oat mite, redlegged earth mite | 70 to 150 g ac/ha (ground spray) | Not supported – safety (worker exposure) concerns. |
| False wireworms | 125 g ac/310 kg seed | Not supported – safety (environment and worker exposure) and trade concerns. |
| Wireworm, false wireworm, sugarcane wireworm | 2.5 g–7.5 g ac/100 m row or 250–750 g ac/ha for row spacing of 1 m | Not supported – safety (worker exposure) and trade concerns. |
| Cotton, lucerne, maize, sorghum, sunflower | False wireworms, brown field cricket, cockroaches | 50 g ac/ha  *(with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)* | Not supported – safety (environment and worker exposure) and trade concerns. |
| Earwigs | 100 g ac/ha  *(with 250 mL sunflower oil in 5 kg cracked wheat or cracked sorghum bait)* | Not supported – safety (environment and worker exposure) and trade concerns. |
| Field peas, lupins, broad beans, and chickpeas | Redlegged earth mite, blue oat mite | 70 to 150 g ac/ha | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Field peas, lupins | Redlegged earth mite (including synthetic pyrethroid resistant biotypes), brown pasture, looper, lucerne flea | 100 to 200 g ac/ha | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Blue oat mite | 200 g ac/ha | Not supported – use is not considered practical with the application restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Pasture webworm | 200 g ac/ha | Not supported – use is not considered practical with the work rate restriction required to mitigate safety (worker exposure with broadacre use) concerns. |
| Hops | Common armyworm, southern armyworm, light brown apple moth | 800 g ac/ha  *(80 g ac/100 L water, applied using 1,000 L water/ha)* | Not supported – safety (worker exposure) concerns. |
| Improved annual pastures, established perennial pastures | Blue oat mite, redlegged earth mite | 70 to 150 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne | Cutworms | 450 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Cutworms, webspinner, caterpillar | 350 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne leafroller | 150 to 200 g ac/ha | Not supported – safety (environment) concerns. |
| Blue oat mite, redlegged earth mite | 70 to 150 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne, medics | Sitona Weevil | 175 g ac/ha | Not supported – safety (environment) concerns. |
| Bluegreen aphid, spotted alfalfa aphid, pea aphid | 100 to 150 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne, subterranean clover, clover | Bryobia mite | 400 g ac/ha | Not supported – safety (environment) concerns. |
| Blue oat mite, pasture webworm | 200 g ac/ha | Not supported – safety (environment) concerns. |
| Redlegged earth mite (including synthetic pyrethroid resistant biotypes), pasture looper, lucerne flea | 100 to 200 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne pastures, clover seed crops | Blue oat mite, redlegged earth mite | 70 to 150 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne seed crops | Webspinner caterpillar | 350 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne leafroller | 150 to 200 g ac/ha | Not supported – safety (environment) concerns. |
| Sitona Weevil | 175 g ac/ha | Not supported – safety (environment) concerns. |
| Bluegreen aphid, spotted alfalfa aphid, pea aphid, lucerne flea | 100 to 150 g ac/ha | Not supported – safety (environment) concerns. |
| Maize | African black beetle | 10 g/100 m row or 1,000 g ac/ha for row spacing of 1 m | Not supported – safety (environment and worker exposure) and trade concerns. |
| Wireworm, false wireworm, sugarcane wireworm | 2.5 g–7.5 g ac/100 m row or 250–750 g ac/ha for row spacing of 1 m | Not supported – safety (worker exposure) and trade concerns. |
| Oilseeds (excluding canola and cotton) | Cutworms | 450 g ac/ha | Not supported – safety (worker exposure) concerns. |
| 350 g ac/ha | Not supported – safety (environment) concerns. |
| Wingless grasshopper | 250 g ac/ha | Not supported – safety (environment) concerns. |
| Redlegged earth mite, blue oat mite | 70–110 g ac/ha (ground spray) | Not supported – safety (residues) concerns. |
| >110–150 g ac/ha (ground spray) | Not supported – safety (environment) concerns. |
| False wireworms | 125 g ac/310 kg seed | Not supported – safety (environment and worker exposure) concerns. |
| Pasture and forage crops | Corbie, winter corbie | 450 or 750 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Spur throated locust | 625 or 750 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Blackheaded pasture cockchafer | 450 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Cutworms | 450 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Underground grass grub | 450 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Armyworm | 350 to 450 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Cutworms, lawn armyworm, sod webworm, brown pasture looper, pasture webworm | 350 g ac/ha | Not supported – safety (environment) concerns. |
| Australian plague locust | 280 g ac/ha | Not supported – safety (environment) concerns. |
| Wingless grasshopper | 250 g ac/ha | Not supported – safety (environment) concerns. |
| Australian plague locust, migratory locust, sitonia weevil | 175 g ac/ha | Not supported – safety (environment) concerns. |
| Pasture webworm | 150 g ac/ha | Not supported – safety (environment) concerns. |
| Spotted alfalfa aphid, blue-green aphid, pea aphid | 100 to 150 g ac/ha | Not supported – safety (environment) concerns. |
| Blue oat mite, redlegged earth mite, pea aphid | 35 to 70 g ac/ha | Not supported – safety (environment) concerns. |
| Lucerne flea | 35 g ac/ha | Not supported – safety (environment) concerns. |
| Pulses (cowpea, chickpea, mung bean, pigeon pea navy bean, and soybean) | False wireworms, wireworms, brown field cricket, cockroaches | 50 g ac/ha  *(with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)* | Not supported – safety (environment and worker exposure) and trade concerns. |
| Rice | Brown plant hopper | 750 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Bloodworm | 30 or 75 g ac/ha | Not supported – trade concerns. |
| Safflower | Wireworm, false wireworm | 2.5 g–7.5 g ac/100 m row or 250–750 g ac/ha for row spacing of 1 m | Not supported – safety (worker exposure) concerns. |
| Sorghum (excluding Sugar Drip or Alpha Sorghum) | Wireworm, false wireworm | 2.5 g–7.5 g ac/100 m row or 250–750 g ac/ha for row spacing of 1 m | Not supported – safety (worker exposure) and trade concerns. |
| Spur throated locust | 625 to 750 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Armyworms, Cutworm | 350 to 450 g ac/ha | Not supported – safety (worker exposure) and trade concerns. |
| Corn aphid, sorghum midge | 250 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Australian plague locust, migratory locust | 175 g ac/ha | Not supported – safety (worker exposure with broadacre use) and trade concerns. |
| Sugarcane | Symphylids | 1,000 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Sugarcane wireworm, African black beetle, beetle | 750 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Spur throated locust | 625 or 750 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Southern armyworm, common armyworm | 450 g ac/ha | Not supported – safety (worker exposure) concerns. |
| Southern armyworm, common armyworm | 350 g ac/ha | Not supported – safety (environment) concerns. |
| Australian plague locust, migratory locust | 175 g ac/ha | Not supported – safety (environment) concerns. |
| Sunflower | Wireworm, false wireworm | 2.5 g–7.5 g ac/100 m row or 250–750 g ac/ha for row spacing of 1 m | Not supported – safety (worker exposure) and concerns. |
| Tobacco | Wireworm, False wireworm, Cutworm | 1,500 g ac/ha *(pre-plant, soil incorporated)* | Not supported – safety (worker exposure) concerns. |
| Miscellaneous uses | | | |
| Agricultural, commercial and industrial areas (not publicly accessible) | Cockroaches, spiders, silverfish | 4.5 g ac/L water to 5 g ac/L water | Not supported – safety (worker exposure) concerns. |
| Chemical soil barrier around buildings (not publicly accessible) | Termites | 50 g ac/m2 or 100 g ac/m2 *(horizontal barrier)*  1000 g ac/m3 or 2000 g ac/m3 *(vertical barrier)* | Not supported – safety (environment and worker exposure) concerns. |
| Chemical soil barrier around buildings (reticulated or AS Series 3660 systems) | Termites | 50 g ac/m2  *(horizontal barrier)* | Not supported – safety (environment) concerns |
| Chemical soil barrier under buildings (not publicly accessible) | Termites | 50 g ac/m2 or 100 g ac/m2 *(horizontal barrier)*  1000 g ac/m3 or 2000 g ac/m3 *(vertical barrier)* | Not supported – safety (worker exposure) concerns. |
| Chemical soil barrier around poles | Termites | 10 g ac/L water | Not supported – safety (worker exposure) concerns. |
| Commercial and industrial areas (not publicly accessible) | Argentine ants | 10 g ac/100 m2 | Not supported – safety (worker exposure) concerns. |
| Duboisia | Cutworms | 450 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Grapevine rootlings | African black beetle | 8000 g ac/ha  *(2 g ac/vine at 4000 vines/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Macrocarpa hedges | Dimpling bug | 250 g ac/ha  *(25 g ac/100 L water applied using 1,000 L water/ha)* | Not supported – safety (environment and worker exposure) concerns. |
| Ornamental nursery plants | Sciarid fly, shore fly | 250 g ac/m3 potting medium | Not supported – safety (worker exposure) concerns. |
| Pruinose scarab, Argentine scarab, fiddler beetle, opaline cockchafer, black vine weevil | 375 to 500 g ac/m3 potting medium | Not supported – safety (worker exposure) concerns. |
| Outdoor areas (not publicly accessible) | Ants, Argentine Ants | 1 g ac/10 m2 | Not supported – safety (worker exposure) concerns. |
| Polluted water impoundments (permanent water pools) | Mosquito larvae | 1 g ac/10,000 L water or 10 g ac/100 m3 | Not supported – safety (environment and worker exposure) concerns. |
| Polluted water impoundments (temporary water pools) | Mosquito larvae | 1 g ac/10,000 L water or 10 g ac/100 m3 | Not supported – safety (worker exposure) concerns. |
| Tasmanian blue gum | African black beetle | 1500 g ac/ha  *(1.5 g ac/seedling at 1000 seedlings/ha)* | Not supported – safety (worker exposure) concerns. |
| Treatment of termite nest or colony (outdoor) | Termites | 5 g ac/L water | Not supported – safety (environment) concerns. |
| Turf (Commercial) | African black beetle | 3,000 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Argentine stem weevil | 2,000 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Funnel Ant, crickets | 1,000 g ac/ha | Not supported – safety (environment and worker exposure) concerns. |
| Blackheaded pasture cockchafer, underground grass grub, winter corbie | 450 g ac/ha | Not supported – safety (environment) concerns. |
| Brown pasture looper, pasture webworm, lawn armyworm, sod webworm | 350 g ac/ha | Not supported – safety (environment) concerns. |
| Crickets | 10 g ac/20 L water | Not supported – safety (environment) concerns. |
| 12.5 g ac//ha *(applied in in 2.5 kg bran bait)* | Not supported – safety (environment and worker exposure) concerns. |
| 50 g ac/ha  *(with 125 mL sunflower oil in 2.5 kg cracked wheat or cracked sorghum bait)* | Not supported – safety (environment and worker exposure) concerns. |
| Vegetation (light to medium, not publicly accessible) | Mosquito adults | 29 to 32 g ac/ha | Not supported – safety (environment) concerns. |
| Vegetation (medium to heavy, not publicly accessible) | Mosquito adults | 52 to 54 g ac/ha | Not supported – safety (environment) concerns. |
| Vegetation (light, not publicly accessible) | Mosquito larvae | 13 to 15 g ac/ha | Not supported – use is not considered practical based on pest activity in this situation. |
| Vegetation (medium, not publicly accessible) | Mosquito larvae | 29 to 32 g ac/ha | Not supported – use is not considered practical based on pest activity in this situation. |
| Vegetation (heavy, not publicly accessible) | Mosquito larvae | 52 to 54 g ac/ha | Not supported – use is not considered practical based on pest activity in this situation. |

1 Many uses that were not supported based on human health or food safety grounds have not been reconsidered in the environment assessment. Additional environmental concerns not indicated in this table may therefore exist for some uses.

Appendix B – Listing of environmental endpoints

Table 41: Physical and chemical properties

| Substance | Study | Result | Reference |
| --- | --- | --- | --- |
| Chlorpyrifos | Vapour pressure | 2.4 × 10-4 Pa at 25°C | Karambelkar 2011a |
|  |  | 2.3 × 10-3 Pa at 25°C  3.4 × 10-3 Pa at 20°C | Shubha 2015a |
|  |  | 4.3 × 10-3 Pa at 25°C | Vohra 2009a |
|  | Henry’s law constant | 0.30 Pa m3/mol | Calculated |
|  | Solubility in water | 0.64 mg/L at 25°C | Karambelkar 2011b |
|  |  | 1.3 mg/L at 20°C | Shubha 2015b |
|  |  | 1.4 mg/L at 20°C | Vohra 2009b |
|  | Partition coefficient | log Pow 4.89 at 25°C | Shubha 2014a |
|  |  | log Pow 4.76 at 20°C | Suratwala 2009 |
|  | Dissociation constant | No dissociation | Shubha 2014b |
|  | UV-VIS absorption (max) | Solution λmax ε (L/mol/cm) |  |
|  |  | Acidic 285 nm 5377  Neutral 285 nm 5274  Alkaline 285 nm 5206 | Shubha 2014c |
|  |  | Acidic 289 nm 6167  Acidic 230 nm 11787  Acidic 206 nm 11620  Neutral 289 nm 6027  Neutral 230 nm 11301  Neutral 207 nm 9903  Alkaline 324 nm 1157  Alkaline 290 nm 5630  Alkaline 230 nm 1991 | Singh 2009 |
| TMP | Vapour pressure | 1.3 × 10-3 Pa at 25°C  0.9 × 10-3 Pa at 20°C | Comb 2002 |
|  | Solubility in water | 7.8 mg/L at 20°C | Sabourin & South 2002a |
|  | Partition coefficient | log Pow 3.7 | Sabourin & South 2002b |
| TMP | UV-VIS absorption (max) | Solution λmax ε (L/mol/cm)  Acidic 205 nm 9400  Acidic 233 nm 9400  Acidic 296 nm 6700  Neutral 206 nm 8800  Neutral 232 nm 9500  Neutral 296 nm 6700  Alkaline 232 nm 8400  Alkaline 296 nm 6000 | Madsen & Humfleet 2004 |
| TCP | Vapour pressure | 3.3 mPa at 25oC | Meikle & Hamaker 1981 |
|  | Henry’s law constant | 2.0 × 10-3 Pa m3 mol-1 at 20°C | Watson 2002 |
|  | Solubility in water | pH 4, 20°C: 195 mg/L  pH 7, 20°C: 3,007 mg/L  pH 9, 20°C: 12,340 mg/L | Roulin 2002 |
|  | Partition coefficient | log Pow 1.8 | Comb 2001 |
|  | Dissociation constant | pKa 4.55 | Meikle & Hamaker 1981 |

Table 42: Fate and behaviour in soil

| Study | Substance | Result | Reference |
| --- | --- | --- | --- |
| Soil photolysis | Chlorpyrifos | Silt loam DT50 30 h (light), 29 h (dark)  5% mineralisation, 32% bound residues after 30d  Max 47% TCP | Havens et al. 1992 |
|  | TCP | Silt loam DT50 14 d (light), 102 d (dark) | Shepler et al. 1994 |
| Aerobic laboratory soil | Chlorpyrifos | Silt loam: DT50 30 d  Sandy clay loam: DT50 6.0 d  Sandy loam: DT50 30 d  Clay loam: DT50 42 d | Abu 2015a, Clark 2013 |
|  |  | Sandy clay loam: DT50 90 d  Silty clay loam: DT50 65 d  Sand: DT50 110 d  Sandy silt loam: DT50 47 d | Abu 2015a, de Vette & Schoonmade 2001a |
|  |  | Geomean DT50 40 d |  |
|  |  | 8–54% mineralisation, 8.4–25% bound residues at 84–120 d  Max 60% TCP |  |
| Aerobic laboratory soil | TMP | Sandy clay loam: DT50 17 d  Clay loam: DT50 12 d | Abu 2015a, Clark 2013 |
|  | TCP | Silt loam: DT50 13 d  Sandy loam: DT50 27 d  Sandy clay loam: DT50 22 d  Clay loam: DT50 10 d | Abu 2015a, Clark 2013 |
|  |  | Silty clay loam: DT50 6.0 d  Sand: DT50 8.6 d | Abu 2015a, de Vette & Schoonmade 2001a |
|  |  | Sandy clay loam: DT50 121 d  Silty clay loam: DT50 7.2 d  Sand: DT50 12 d  Sandy silt loam: DT50 47 d | Abu 2015a, Brüll et al. 2002, de Vette & Schoonmade 2001b |
|  | DCP | Clay loam: DT50 9.3 d  Sandy loam: DT50 11 d  Silt loam: DT50 8.5 d  Sandy loam DT50 7.5 d | Abu 2015b, Ross 2015 |
| Anaerobic laboratory soil | Chlorpyrifos | Sandy loam: DT50 11 d  Loam: DT50 13 d  Clay: DT50 23 d  Sandy loam: DT50 23 d  Geomean DT50 17 d  2.1–5.5% mineralisation, 13–22% bound residues at 120 d  Max 82% TCP  Max 67% DCP | Jackson 2015, Kang 2014a |
| Anaerobic laboratory soil | TCP | Sandy loam: DT50 46 d  Loam: DT50 21 d  Clay: DT50 82 d  Sandy loam: DT50 47 d  Geomean DT50 44 d | Jackson 2015. Kang 2014a |
| Adsorption/  desorption | Chlorpyrifos | Soil %OC Kf Kfoc 1/n  Clay loam 3.5 53 1520 0.86  Sand 1.5 77 5113 0.90  Loam 1.0 49 4870 0.97  Sandy clay loam 1.6 45 2825 0.90  Sandy loam 4.3 234 5442 0.94  Geomean Kfoc 3572 mL/g, mean 1/n 0.92 | Damon & Heim 2001 |
| Adsorption/  desorption | TMP | Soil %OC Kf Kfoc 1/n  Clay loam 3.1 11 323 0.81  Sand 1.5 9.3 619 0.88  Loam 1.0 5.6 562 0.88  Sandy clay loam 1.5 8.7 543 0.73  Sandy loam 4.3 28 640 0.89  Geomean Kfoc 523 mL/g, mean 1/n 0.84 | Heim & Damon 2001 |
|  | TCP | Soil %OC Kf Kfoc 1/n |  |
|  |  | Clay loam 3.5 1.8 51 0.89  Sand 1.5 1.3 86 0.83  Loam 1.0 0.68 68 0.79  Sandy clay loam 1.6 1.7 105 0.75  Sandy loam 4.3 6.4 14 0.80 | Damon & Sarff 2001 |
|  |  | Clay loam 2.5 2.0 77 0.78  Sandy loam 0.3 0.60 194 0.81  Silt loam 2.1 1.7 81 0.78 | Racke & Lubinski 1992 |
|  |  | Geomean Kfoc 93 mL/g, mean 1/n 0.80 |  |
| Adsorption/  desorption | DCP | Soil %OC Kf Kfoc 1/n  Sandy loam 0.81 0.69 85 0.80  Clay loam 3.5 3.5 99 0.77  Sandy loam 1.3 0.23 18 0.78  Silt loam 5.3 0.69 13 0.81  Loam 0.64 0.12 19 0.75  Geomean Kfoc 33 mL/g, mean 1/n 0.78 | Grant & McLachlan 2015 |
| Field dissipation | Chlorpyrifos | France: DT50 25 d | Abu 2015c, Old 2002b |
|  | Greece: DT50 15 d | Abu 2015c, Old 2002c |
|  |  | Spain: DT50 5.2 d | Abu 2015c, Old 2002d |
|  |  | Illinois: DT50 106 d  Michigan: DT50 38 d  California: DT50 66 d | Abu 2015c, Fontaine et al. 1987 |
|  |  | Geomean DT50 28 d |  |
|  | TCP | Greece: DT50 43 d | Abu 2015c, Old 2002c |
|  |  | Spain: DT50 111 d | Abu 2015c, Old 2002d |
|  |  | California: DT50 42 d | Abu 2015c, Fontaine et al. 1987 |
|  |  | Geomean DT50 58 d |  |

Table 43: Fate and behaviour in water and sediment

| Study | Substance | Result | Reference |
| --- | --- | --- | --- |
| Ready biodegradability | Chlorpyrifos | Not readily biodegradable | Douglas & Pell 1985 |
| Hydrolysis | Chlorpyrifos | pH 4.0, 25°C: DT50 93 d  pH 7.0, 25°C: DT50 63 d  pH 9.0, 25°C: DT50 34 d | Anand 2016a |
|  |  | pH 5.0, 25°C: DT50 73 d  pH 7.0, 25°C: DT50 72 d  pH 9.0, 25°C: DT50 16 d | McCall 1986 |
|  |  | pH 4.7, 25°C: DT50 63 d  pH 6.9, 25°C: DT50 35 d  pH 8.1, 25°C: DT50 23 d | Meikle & Youngson 1977 |
| Aqueous photolysis | Chlorpyrifos | DT50 17 d at 40°N in summer  DT50 21 d at 40°N in spring  DT50 36 d at 40°N in fall | Anand 2016b |
| Aerobic mineralisation in surface water | Chlorpyrifos | Low dose: DT50 55 d  High dose: DT50 25 d  0.8–0.9% mineralisation at 61 d | Curtis-Jackson & Gassen 2015 |
| Degradation in water/sediment | Chlorpyrifos | Calwich Abbey: DT50 31 d  Swiss Lake: DT50 58 d  Geomean DT50 42 d  7.4–9.2% mineralisation, 6.7–12% bound residue after 150 d  Max 54% chlorpyrifos in sediment  Max 67% TCP (47% in water, 27% in sediment) | Abu 2015d, Kang 2015 |

Table 44: Fate and behaviour in air

| Study | Substance | Result | Reference |
| --- | --- | --- | --- |
| Photochemical oxidative degradation | Chlorpyrifos | DT50 1.4 h | Simon 2001 |
|  | TMP | DT50 60 d | Simon 2001 |
|  | TCP | DT50 12 d | Simon 2001 |
| Volatilisation | Chlorpyrifos | 79–81% after 24 h from plant surfaces  22–26% after 24 h from soil surfaces | Day & Rüdel 1993 |

Table 45: Effects on mammals

| Exposure | Species | Test substance | Toxicity value | Reference |
| --- | --- | --- | --- | --- |
| Acute | *Rattus norvegicus* | Chlorpyrifos | LD50 >50 mg ac/kg bw/d | Kumar 2014, Pandya 2008, Patel 2015, Suryawanshi 2008 |
|  |  |  | LD50 97 mg ac/kg bw/d | Henck & Kociba 1980 |
|  |  |  | LD50 >300 mg ac/kg bw/d | Ilamurugan 2011 |
|  |  | TMP | LD50 >2000 mg/kg bw/d | Verma 2013a |
|  |  | TCP | LD50 3129 mg/kg bw/d | Durando 2005 |
|  |  | DCP | LD50 >2000 mg/kg bw/d | Verma 2015 |
|  | *Mus musculus* | Chlorpyrifos | LD50 >50 mg ac/kg bw/d | Verma 2013b |
| Chronic | *Rattus norvegicus* | Chlorpyrifos | NOEL 1.0 mg ac/kg bw/d | Breslin et al. 1991 |

Table 46: Effects on birds

| Test substance | Exposure | Species | Toxicity value | Reference |
| --- | --- | --- | --- | --- |
| Chlorpyrifos | Acute | *Quiscalus quiscula* | LD50 5.6 mg ac/kg bw | Schafer & Brunton 1979 |
|  |  |  | LD50 13 mg ac/kg bw | Schafer & Brunton 1971 |
|  |  |  | Geomean LD50 8.5 mg ac/kg bw |  |
|  |  | *Phasianus colchicus* | LD50 12 mg ac/kg bw | Hudson et al. 1984 |
|  |  | *Agelaius phoeniceus* | LD50 13 mg ac/kg bw | Schafer & Brunton 1979 |
|  |  | *Columba livia* | LD50 10 mg ac/kg bw | Schafer & Brunton 1979 |
|  |  |  | LD50 27 mg ac/kg bw | Hudson et al. 1984 |
|  |  |  | Geomean LD50 16 mg ac/kg bw |  |
| Chlorpyrifos | Acute | *Coturnix japonica* | LD50 12 mg ac/kg bw | Yogeesh 2014 |
|  |  |  | LD50 13 mg ac/kg bw | Schafer & Brunton 1979 |
|  |  |  | LD50 17 mg ac/kg bw | Hudson et al. 1984 |
|  |  |  | LD50 60 mg ac/kg bw | Sharma 2008a |
|  |  |  | Geomean LD50 20 mg ac/kg bw |  |
|  |  | *Passer domesticus* | LD50 10 mg ac/kg bw | Schafer & Brunton 1979 |
|  |  |  | LD50 21 mg ac/kg bw | Hudson et al. 1984 |
|  |  |  | LD50 122 mg ac/kg bw | Gallagher et al. 1996 |
|  |  |  | Geomean LD50 29 mg ac/kg bw |  |
|  |  | *Gallus gallus* | LD50 25 mg ac/kg bw | Sherman et al. 1967 |
|  |  |  | LD50 32 mg ac/kg bw | Stevenson 1963 |
|  |  |  | LD50 35 mg ac/kg bw | Miyazaki & Hodgson 1972 |
|  |  |  | Geomean LD50 30 mg ac/kg bw |  |
|  |  | *Grus canadensis* | LD50 38 mg ac/kg bw | Hudson et al. 1984 |
|  |  | *Colinus virginianus* | LD50 25 mg ac/kg bw | Lloyd et al. 1989a |
|  |  |  | LD50 32 mg ac/kg bw | Smith 1987 |
|  |  |  | LD50 38 mg ac/kg bw | Rodgers 1996 |
|  |  |  | LD50 53 mg ac/kg bw | Bull & Cameron 2013 |
|  |  |  | LD50 128 mg ac/kg bw | Lloyd et al. 1989b |
|  |  |  | Geomean LD50 46 mg ac/kg bw |  |
|  |  | *Brania canadensis* | LD50 60 mg ac/kg bw | Hudson et al. 1984 |
|  |  | *Alectoris chukar* | LD50 61 mg ac/kg bw | Hudson et al. 1984 |
|  |  | *Callipepla californica* | LD50 68 mg ac/kg bw | Hudson et al. 1984 |
|  |  | *Agelaius phoeniceus* | LD50 75 mg ac/kg bw | Schafer & Brunton 1979 |
|  |  | *Anas platyrhynchos* | LD50 95 mg ac/kg bw | Hudson et al. 1972 |
|  | Dietary | *Colinus virginianus* | LD50 75 mg ac/kg bw/d | Gallagher & Beavers 2007 |
|  |  | *Anas platyrhynchos* | LD50 71 mg ac/kg bw/d | Roberts & Phillips 1987 |
|  | Chronic | *Colinus virginianus* | NOEL 11 mg ac/kg bw/d | Beavers & Fink 1978a |
|  |  | *Anas platyrhynchos* | NOEL 2.9 mg ac/kg bw/d | Beavers & Fink 1978b |
| TCP | Acute | *Colinus virginianus* | LD50 >2000 mg/kg bw | Campbell et al. 1990 |
|  | Dietary | *Anas platyrhynchos* | LD50 >1027 mg/kg bw/d | Long et al. 1990 |

Table 47: Field studies on birds

| Test substance | Crop | Exposure | Effect | Reference |
| --- | --- | --- | --- | --- |
| EC 480 g/L | Brassica | 2 × 960 g ac/ha  14d interval | No impact on bird community (1,598 bird sightings of 46 species; 6 nests monitored, 53 birds radiotracked) | Moosmayer & Wilkens 2008 |
|  | Grapes | 2 × 360 g ac/ha  15d interval | No short-term negative impacts on birds, including buntings, redstarts, stonechats and jays | Brown et al. 2007 |
| WG 750 g/kg | Citrus | 2 × 2400 g ac/ha  14d interval | No impact on bird community, including warblers, blackbirds, tits, serins, and martins | Selbach & Wilkens 2008 |
|  | Pome fruit | 2–3× 960 g ac/ha  14–28d interval | No impact on bird community, including blackbirds, blackcaps, warblers, tits, nightingales, flycatcher | Wilkens et al. 2008b |
| Various commercial | Citrus | 1200–3360 g ac/ha | No impact on bird community, including serins, finches, sparrows, swallows, nightingales and warblers | Dittrich & Staedler 2010 |
|  | Citrus, brassicas, pome fruit | 1–3× 500–2400 g ac/ha  14d interval | No impact on bird community, including warblers, flycatchers, wagtails, blackbirds, blackcaps, tits and skylarks | Wolf et al. 2010 |

Table 48: Effects on fish

| Exposure | Species | Test substance | Toxicity value | Reference |
| --- | --- | --- | --- | --- |
| Acute | *Oncorhynchus mykiss* | Chlorpyrifos | LC50 0.025 mg ac/L | Bowmann 1988 |
|  |  | EC 480 g/L | LC50 0.022 mg ac/L | McMinn 1995 |
|  |  | CS 250 g/L | LC50 26 mg ac/L | Sewell & Grant-Salmon 1993 |
|  |  | TMP | LC50 1.0 mg/L | Hamitou 2010a |
|  |  | TCP | LC50 13 mg/L | Gorzinski et al. 1991a |
|  | *Leuciscus idus* | Chlorpyrifos | LC50 0.010 mg ac/L | Douglas & Bell 1985a |
|  | *Cyprinus carpio* | Chlorpyrifos | LC50 0.024 mg ac/L | Bopanna 2014a |
|  | *Cyprinodon variegatus* | Chlorpyrifos | LC50 >0.076 mg ac/L | Surprenant 1989a |
|  | *Rutilus rutilus* | Chlorpyrifos | LC50 0.25 mg ac/L | Douglas & Bell 1985b |
|  | *Pimephales promelas* | Chlorpyrifos | LC50 0.14 mg ac/L | Jarvinen & Tanner 1982 |
|  |  | CS 100 g/L | LC50 0.12 mg ac/L | Jarvinen & Tanner 1982 |
|  |  | DCP | LC50 >15 mg/L | Tanneberger 2015 |
|  | *Lepomis macrochirus* | TCP | LC50 12 mg/L | Gorzinski et al. 1991b |
|  | *Menidia menidia* | TCP | LC50 58 mg/L | Graves & Smith 1991 |
| Chronic | *Oncorhynchus mykiss* | Chlorpyrifos | NOEC 0.00051 mg ac/L | Adema 1990 |
|  |  | TCP | NOEC 0.081 mg/L | Marino et al. 1999 |
|  | *Menidia peninsulae* | Chlorpyrifos | NOEC 0.00038 mg ac/L | Goodman et al. 1985 |
|  | *Pimephales promelas* | Chlorpyrifos | NOEC 0.00057 mg ac/L | Mayes et al. 1993 |
|  | *Menidia beryllina* | Chlorpyrifos | NOEC 0.00075 mg ac/L | Goodman et al. 1985 |

Table 49: Effects on aquatic invertebrates and sediment dwellers

| Exposure | Species | Test substance | Toxicity value | Reference |
| --- | --- | --- | --- | --- |
| Acute | *Daphnia magna* | Chlorpyrifos | EC50 0.0013 mg ac/L | Bopanna 2014b |
|  |  |  | EC50 0.00010 mg ac/L | Burgess 1988 |
|  |  | EC 480 g/L | EC50 0.0012 mg ac/L | van der Kolk 1995a |
|  |  | TMP | EC50 4.0 mg/L | Hamitou 2010b |
|  |  | TCP | EC50 10 mg/L | Gorzinski et al. 1991c |
|  |  | DCP | EC50 39 mg/L | Hoberg 2005 |
|  | *Mysidopsis bahia* | Chlorpyrifos | LC50 0.000045 mg ac/L | Surprenant 1989b |
|  | *Hyalella azteca* | Chlorpyrifos | LC50 0.00014 mg ac/L | Brown et al. 1997 |
|  | *Crassostrea virginica* | Chlorpyrifos | EC50 0.084 mg ac/L | Surprenant 1989c |
| Chronic | *Daphnia magna* | Chlorpyrifos | NOEC 0.000056 mg/L | Adema & de Ruiter 1990 |
|  |  | TCP | NOEC 0.029 mg/L | Machado 2003 |
|  | *Mysidopsis bahia* | Chlorpyrifos | NOEC 0.0000046 mg ac/L | Sved et al. 1993 |
|  | *Chironomus riparius* | DCP | NOEC 33 mg/L | Putt 2005 |
|  | Microcosm/mesocosm | EC 480 g/L | NOEC 0.00010 mg ac/L | Daam 2008, Giddings 1993, 2011, López-Mancisidor 2015, López-Mancisidor et al. 2008, van den Brink et al. 1996, van Wijngaarden et al. 2005 |

Table 50: Effects on algae and aquatic plants

| Group | Species | Test substance | Toxicity value | Reference |
| --- | --- | --- | --- | --- |
| Algae | *Pseudokirchneriella subcapitata* | Chlorpyrifos | ErC50 1.0 mg ac/L | Bopanna 2014c |
|  |  | EC 480 g/L | EbC50 0.064 mg/L | van der Kolk 1995b |
|  |  | TMP | ErC50 3.3 mg/L | Biester 2010 |
|  |  | TCP | ErC50 1.1 mg/L | Kirk et al. 1999 |
|  | *Scenedesmus subspicatus* | Chlorpyrifos | EbC50 0.48 mg/L | Douglas et al. 1990 |
|  | *Anabaena flos-aquae* | TCP | EC50 1.4 mg/L | Kirk et al. 2000a |
|  | *Navicula pelliculosa* | TCP | ErC50 8.9 mg/L | Sayers 2003 |
|  |  | DCP | ErC50 12 mg/L | Hoberg 2006 |
| Aquatic plants | *Lemna gibba* | TCP | EC50 8.8 mg/L | Kirk et al. 2000b |

Table 51: Effects on bees

| Species | Life stage | Exposure | Test substance | Toxicity value | Reference |
| --- | --- | --- | --- | --- | --- |
| Apis mellifera | Adult | Acute contact | Chlorpyrifos | LD50 0.080 µg ac/bee | Suresh 2015 |
|  |  |  |  | LD50 0.070 µg ac/bee | Bell 1994 |
|  |  |  |  | Geomean LD50 0.075 µg ac/bee |  |
|  |  |  | EC 480 g/L | LD50 0.10 µg ac/bee | Bell 1993 |
| Apis mellifera | Adult | Acute oral | Chlorpyrifos | LD50 0.21 µg ac/bee | Suresh 2014 |
|  |  |  |  | LD50 0.13 µg ac/bee | Sharma 2008b |
|  |  |  |  | LD50 0.36 µg ac/bee | Bell 1994 |
|  |  |  |  | Geomean LD50 0.21 µg ac/bee |  |
|  |  |  | EC 480 g/L | LD50 0.15 µg ac/bee | Bell 1993 |
|  | Larval | Acute | Chlorpyrifos | LD50 0.021 µg ac/bee | Odemer 2015 |

Table 52: Semi-field studies on bees

| Test substance | Crop | Application | Effect | Reference |
| --- | --- | --- | --- | --- |
| WG 750 g/kg | *Phacelia tanacetafolia*  Flowering | 1000 g ac/ha  Before flight | Reduced foraging activity in aged residues up to 14 days, but no increased mortality | Bakker 2000 |
|  |  | 1000 g ac/ha  During flight | Significant mortality during flight and 1-day old residues. Reduced foraging activity in aged residues up to 3 days | Bakker 2002 |
| EC 225 g/L | *Phacelia tanacetafolia*  Flowering | 1000 g ac/ha  During flight | Significant mortality during flight and 1-day old residues. Reduced foraging activity in aged residues up to 3 days | Bakker 2002 |

Table 53: Field studies on non-target arthropods

| Test substance | Crop | Application | Effect | Reference |
| --- | --- | --- | --- | --- |
| EC 480 g/L | Grassland | 720 g ac/ha | Initial high toxicity to spring populations of carabid and staphylinid beetles and linyphiid. All groups recovered by following spring except Collembola. | Brown 1993 |
|  | Pome fruit | 960 g ac/ha | Acute toxicity to most non-target and beneficial taxa (predatory bugs, ladybirds, spiders, earwigs, parasitic wasps). Most species showed recovery 11–23 days after treatment except Heteroptera. | Brown 1991 |

Table 54: Effects on soil macro-organisms

| Exposure | Species | Test substance | Toxicity value | Reference |
| --- | --- | --- | --- | --- |
| Acute | *Eisenia fetida* | Chlorpyrifos | LC50corr 160 mg ac/kg dry soil | Bopanna 2014d |
|  |  |  | LC50corr 105 mg ac/kg dry soil | Rodgers 1994 |
|  |  |  | Geomean LC50corr 130 mg ac/kg dry soil |  |
|  |  | EC 480 g/L | LC50corr 82 mg ac/kg dry soil | Candolfi 1995 |
|  |  |  | LC50corr 71 mg ac/kg dry soil | Johnson 1993 |
|  |  |  | Geomean LC50corr 76 mg ac/kg dry soil |  |
|  |  | TMP | LC50corr 48 mg/kg dry soil | Hoffmann 2009 |
|  |  | TCP | LC50corr 9.8 mg/kg dry soil | Ward & Boeri 1999 |
| Chronic | *Eisenia fetida* | EC 480 g/L | NOECcorr 6.4 mg ac/kg dry soil | Hayward 2002 |
|  |  | TCP | NOECcorr 1.1 mg/kg dry soil | Mallett 2003 |
|  |  | DCP | EC10corr 0.88 mg/kg dry soil | Ganßmann 2015 |
|  | *Hypoaspis aculeifer* | TCP | EC10 >50 mg/kg dry soil | Vinall 2011a |
|  | *Folsomia candida* | TCP | NOEC 50 mg/kg dry soil | Vinall 2011b |

Table 55: Effects on soil processes

| Exposure | Process | Test substance | Toxicity value | Reference |
| --- | --- | --- | --- | --- |
| Chronic | Respiration | EC 480 g/L | NOEC 6.4 mg ac/kg dry soil | Baloch & Hund 1990 |
|  |  | TMP | NOEC 2.1 mg/kg dry soil | Baumgartner 2009 |
|  |  | TCP | NOEC 4.7 mg/kg dry soil | Mallett & Hayward 1999 |
|  | Nitrification | EC 480 g/L | NOEC 6.4 mg ac/kg dry soil | Baloch & Hund 1990, Baloch & Todt 1990 |
|  |  |  | NOEC 9.6 mg ac/kg dry soil | McGibbon et al. 1989 |
|  |  | TMP | NOEC 2.1 mg/kg dry soil | Baumgartner 2009 |
|  |  | TCP | NOEC 4.7 mg/kg dry soil | Mallett & Hayward 1999 |

Table 56: Effects on non-target terrestrial plants (pre-emergent exposure)

| Test substance | Species | ER25 | ER50 | Reference |
| --- | --- | --- | --- | --- |
| EC 480 g/L  WG 750 g/kg  CS 200 g/L | *Abutilon theophasti*  *Alopecurus myosuroides*  *Avena fatua*  *Beta vulgaris*  *Chenopodium album*  *Digitaria sanguinalis*  *Echinochloa crus-galli*  *Euphorbia heterophylla*  *Glycine max*  *Helianthus annus*  *Ipomoea hederacea*  *Oryza sativa*  *Sorghum bicolour*  *Triticum aestivum*  *Zea mays* | >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha | >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha | Paterson & Toft 2007a |
| EW 450 g/L | *Lactuca sativa*  *Cucumis sativus*  *Allium cepa*  *Avena sativa*  *Brassica oleraca*  *Daucus carota*  *Glycine max*  *Lolium perenne*  *Lycopersicon esculentum*  *Zea mays* | 2670 g ac/ha  5720 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha | >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha | Bergfield 2011a, 2012a |

Table 57: Effects on non-target terrestrial plants (post-emergent exposure)

| Test substance | Species | ER25 | ER50 | Reference |
| --- | --- | --- | --- | --- |
| EC 480 g/L  WG 750 g/kg  CS 200 g/L | *Abutilon theophasti*  *Alopecurus myosuroides*  *Amaranthus retroflexus*  *Avena fatua*  *Beta vulgaris*  *Brassica napus*  *Chenopodium album*  *Cirisum arvensis*  *Digitaria sanguinalis*  *Echinochloa crus-galli*  *Euphorbia heterophylla*  *Glycine max*  *Helianthus annus*  *Ipomoea hederacea*  *Oryza sativa*  *Polygonum convolvulus*  *Setaria faberii*  *Sorghum bicolour*  *Stellaria media*  *Triticum aestivum*  *Viola tricolor*  *Zea mays* | >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha | >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha  >2400 g ac/ha | Paterson & Toft 2007b |
| EW 450 g/L | *Allium cepa*  *Avena sativa*  *Brassica oleraca*  *Cucumis sativus*  *Daucus carota*  *Glycine max*  *Lactuca sativa*  *Lolium perenne*  *Lycopersicon esculentum*  *Zea mays* | >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha | >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha  >6400 g ac/ha | Bergfield 2011b, 2012b |

Appendix C – Wild mammal assessments

Risks to terrestrial vertebrates following dietary exposure to contaminated food items are assessed using a tiered approach. Based on current assessment methodology, risks to mammals from long-term exposure have been determined to be significantly higher than previously assessed in 2019. Therefore, the updated assessment in this Appendix focuses only on the long-term risks to wild mammals.

The chronic assessment assumes 50% of food items are obtained from the treatment area for the first 21 days after the last application (PT 0.5). In the 2019 assessment, a long-term time-weighted average (TWA) factor of 0.53 was applied (based on default foliar DT50 10 days). However, a TWA factor is no longer automatically applied under the current assessment methodology. In the case of the neonatal effects observed in the 2-generation dietary reproduction study in rats (Breslin et al. 1991), the effects being a result of short-term exposure at a critical life stage could not be excluded. As a result, the TWA was not applied in the current assessment.

For the wild mammal assessment, the use patterns were divided up into groups which consist of crop species that have similar growing patterns (Table A1). It is assumed that the exposure of a ‘generic focal species’ within each group will be the same as they relate to feeding habits and other ecological needs. A ‘generic focal species’ is not a real species; however, it is considered to be representative of all those species potentially at risk. The APVMA utilises the EFSA (2009) generic focal species which are considered protective of species that occur in Australia. Interception of the spray by the crop is taken into account by calculating the residue level on the several food types, depending on the growth stage of the crop.

Acceptable risks of long-term effects on wild mammals could not be concluded for any of the use patterns assessed, which could not be mitigated by restricting the timing of application (Table A2).

Table A1: Seasonal exposure estimates for various environmental matrices

| Use pattern | EFSA 2009 crop group | Situation | Application rate and frequency | Fraction  Field treated | Seasonal exposure rate (g/ha) | |
| --- | --- | --- | --- | --- | --- | --- |
| Insects  (DT50 3.5 d) | Foliage  (DT50 4.0 d) |
| Field crops and pasture | Grassland | Pasture, sugarcane | 2× 350 g ac/ha  7d interval | 1 | 438 | 454 |
| Legume forage | Lucerne, forage crops | 2× 350 g ac/ha  7d interval | 1 | 438 | 454 |
| Oilseed rape | Oilseeds (excluding cotton and canola) | 2× 350 g ac/ha  7d interval | 1 | 438 | 454 |
| Ornamentals/nursery | Duboisia | 1× 450 g ac/ha | 1 | 450 | 450 |
| Tree and vine crops | Vineyards | Grapevines | 1× 250 g ac/ha | 1 | 250 | 250 |
| Orchards | Apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards | 1× 250 g ac/ha | 1 | 250 | 250 |
|  | Orchards | Avocado (spot treatment) | 1× 500 g ac/ha | 0.40 | 200 | 200 |
| Vegetable crops | Leafy vegetables | Vegetables (band application) | 2× 400 g ac/ha  7d interval | 0.50 | 250 | 259 |
| Leafy vegetables | Vegetables (broadcast application) | 2× 350 g ac/ha  7d interval | 1 | 438 | 454 |
|  | Root and stem vegetables | Ginger | 1× 450 g ac/ha | 1 | 450 | 450 |
| Mosquito control | Ornamentals/nursery | Vegetation (mosquito adults) | 4× 54 g ac/ha  7d interval | 1 | 72 | 76 |
| Commercial turf | Grassland | Control of cockchafer, grub or corbie | 1× 450 g ac/ha | 1 | 450 | 450 |
|  |  | Control of other insect pests | 2× 350 g ac/ha  7d interval | 1 | 438 | 454 |
| Combination products | Legume forage | Subterrannean clover, clover, lucerne | 2× 400 g ac/ha  7d interval | 1 | 500 | 519 |
| Fruiting vegetables | Field tomatoes | 2× 250 g ac/ha  7d interval | 1 | 313 | 324 |

Risk assessment scenarios as described in section 2; foliar interception values are based on EFSA (2020) defaults for similar situations; seasonal exposure rates based on indicated application rate, frequency, DT50, fand fraction of field treated (40% for spot treatment, 50% for band application)

Table A2 Long-term risks of chlorpyrifos to wild mammals (RAL 1.0 mg/kg bw/d)

| Crop group | Crop stage | Generic focal species | Shortcut value | Exposure rate (g/ha) | DDD (mg/kg bw/d) | RQ |
| --- | --- | --- | --- | --- | --- | --- |
| Pasture, sugarcane, commercial turf | | | | | | |
| Grassland | All season | Small herbivore | 72.3 | 450 | 16 | **16** |
|  | All season | Large herbivore | 17.3 | 450 | 3.9 | **3.9** |
|  | All season | Small omnivore | 6.6 | 450 | 1.5 | **1.5** |
|  | Late season | Small insectivore | 1.9 | 450 | 0.43 | 0.43 |
| Lucerne, forage crops, combination products (subterranean clover, clover, lucerne) | | | | | | |
| Legume forage | BBCH 40–49 | Small herbivore | 72.3 | 454 | 16 | **16** |
|  | BBCH ≥50 | Small herbivore | 21.7 | 454 | 4.9 | **4.9** |
|  | BBCH 21–49 | Large herbivore | 14.3 | 454 | 3.2 | **3.2** |
|  | BBCH 10–49 | Small omnivore | 7.8 | 454 | 1.8 | **1.8** |
|  | BBCH 10–19 | Small insectivore | 4.2 | 438 | 0.92 | 0.92 |
|  |  |  |  | 500 | 1.1 | **1.1** |
|  | BBCH ≥50 | Small omnivore | 2.3 | 500 | 0.60 | 0.60 |
|  | BBCH ≥20 | Small insectivore | 1.9 | 500 | 0.48 | 0.48 |
| Oilseeds (excluding cotton and canola) | | | | | | |
| Oilseed rape | BBCH ≥40 | Small herbivore | 18.1 | 454 | 4.1 | **4.1** |
| All season | Large herbivore | 14.3 | 454 | 3.2 | **3.2** |
| BBCH 10–29 | Small omnivore | 7.8 | 454 | 1.8 | **1.8** |
| BBCH 10–19 | Small insectivore | 4.2 | 438 | 0.92 | 0.92 |
| BBCH 30–39 | Small omnivore | 2.3 | 454 | 0.52 | 0.52 |
| BBCH ≥40 | Small omnivore | 1.9 | 454 | 0.43 | 0.43 |
| BBCH ≥20 | Small insectivore | 1.9 | 438 | 0.42 | 0.42 |
| Duboisia, adult mosquito control | | | | | | |
| Ornamentals/nursery | BBCH 40–49 | Small herbivore | 72.3 | 76 | 2.7 | **2.7** |
|  | BBCH ≥50 | Small herbivore | 36.1 | 76 | 1.4 | **1.4** |
|  | BBCH 10–49 | Small omnivore | 7.8 | 76 | 0.30 | 0.30 |
|  |  |  |  | 450 | 1.8 | **1.8** |
|  | BBCH ≥50 | Small omnivore | 3.9 | 450 | 0.88 | 0.88 |
|  | All season | Small insectivore | 1.9 | 438 | 0.42 | 0.42 |
| Grapevines | | | | | | |
| Vineyards | Ground directed | Small herbivore | 72.3 | 250 | 9.0 | **9.0** |
|  | BBCH 10–19 | Small herbivore | 43.4 | 250 | 5.4 | **5.4** |
|  | BBCH 20–39 | Small herbivore | 36.1 | 250 | 4.5 | **4.5** |
|  | BBCH ≥40 | Small herbivore | 21.7 | 250 | 2.7 | **2.7** |
|  | Ground directed | Large herbivore | 11.1 | 250 | 1.4 | **1.4** |
|  | Ground directed | Small omnivore | 7.8 | 250 | 0.98 | 0.98 |
|  | BBCH 10–19 | Large herbivore | 6.7 | 250 | 0.84 | 0.84 |
|  | BBCH 20–39 | Large herbivore | 5.5 | 250 | 0.69 | 0.69 |
|  | BBCH 10–19 | Small omnivore | 4.7 | 250 | 0.59 | 0.59 |
|  | BBCH 10–19 | Small insectivore | 4.2 | 250 | 0.53 | 0.53 |
|  | BBCH 20–39 | Small omnivore | 3.9 | 250 | 0.49 | 0.49 |
|  | BBCH ≥40 | Large herbivore | 3.3 | 250 | 0.41 | 0.41 |
|  | BBCH ≥40 | Small omnivore | 2.3 | 250 | 0.29 | 0.29 |
|  | BBCH ≥20 | Small insectivore | 1.9 | 250 | 0.24 | 0.24 |
| Avocado, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards | | | | | | |
| Orchards | BBCH <10 | Small herbivore | 72.3 | 200 | 7.2 | **7.2** |
| BBCH 10–19 | Small herbivore | 57.8 | 200 | 5.8 | **5.8** |
| BBCH 20–40 | Small herbivore | 43.4 | 200 | 4.3 | **4.3** |
| BBCH 71–79 | Frugivore | 22.7 | 200 | 2.3 | **2.3** |
| BBCH ≥40 | Small herbivore | 21.7 | 200 | 2.2 | **2.2** |
| BBCH <10 | Large herbivore | 14.3 | 200 | 1.4 | **1.4** |
| BBCH 10–19 | Large herbivore | 11.5 | 200 | 1.2 | **1.2** |
| BBCH 20–40 | Large herbivore | 8.6 | 200 | 0.86 | 0.86 |
|  |  |  | 250 | 1.1 | **1.1** |
| BBCH <10 | Small omnivore | 7.8 | 250 | 0.98 | 0.98 |
| BBCH 10–19 | Small omnivore | 6.2 | 250 | 0.78 | 0.78 |
| BBCH 20–40 | Small omnivore | 4.7 | 250 | 0.59 | 0.59 |
| BBCH ≥40 | Large herbivore | 4.3 | 250 | 0.54 | 0.54 |
| BBCH ≥40 | Small omnivore | 2.3 | 250 | 0.29 | 0.29 |
| BBCH <10 | Small omnivore | 1.9 | 250 | 0.24 | 0.24 |
| Vegetables (band or broadcast application) | | | | | | |
| Leafy vegetables | BBCH 40–49 | Small herbivore | 72.3 | 259 | 9.4 | **9.4** |
|  | BBCH ≥50 | Small herbivore | 21.7 | 259 | 2.8 | **2.8** |
|  | All season | Large herbivore | 14.3 | 259 | 1.9 | **1.9** |
|  | BBCH 10–49 | Small omnivore | 7.8 | 259 | 1.0 | 1.0 |
|  |  |  |  | 454 | 1.8 | **1.8** |
|  | BBCH 10–49 | Small insectivore | 4.2 | 438 | 0.92 | 0.92 |
|  | BBCH ≥50 | Small omnivore | 2.3 | 454 | 0.52 | 0.52 |
|  | BBCH ≥20 | Small insectivore | 1.9 | 438 | 0.42 | 0.42 |
| Ginger | | | | | | |
| Root and stem vegetables | BBCH ≥40 | Small herbivore | 21.7 | 450 | 4.9 | 4.9 |
| BBCH 10–39 | Small omnivore | 7.8 | 450 | 1.8 | 1.8 |
| BBCH 10–19 | Small insectivore | 4.2 | 450 | 0.95 | 0.95 |
| BBCH ≥40 | Small omnivore | 2.3 | 450 | 0.52 | 0.52 |
| BBCH ≥20 | Small insectivore | 1.9 | 450 | 0.43 | 0.43 |
| Combination products (field tomatoes) | | | | | | |
| Fruiting vegetables | BBCH 10–49 | Small herbivore | 72.3 | 324 | 12 | 12 |
| BBCH 71–89 | Frugivore | 25.2 | 324 | 4.1 | 4.1 |
| BBCH ≥50 | Small herbivore | 21.7 | 324 | 3.5 | 3.5 |
| BBCH 10–49 | Small omnivore | 7.8 | 324 | 1.3 | 1.3 |
| BBCH 10–19 | Small insectivore | 4.2 | 313 | 0.66 | 0.66 |
| BBCH ≥50 | Small omnivore | 2.3 | 324 | 0.37 | 0.37 |
| BBCH ≥20 | Small insectivore | 1.9 | 313 | 0.30 | 0.30 |

Crop groups as indicated in Table A1; generic focal species and shortcut values for indicated crop groups from EFSA (2009)

Seasonal exposure rates selected from Table A1 for the indicated crop groups represent worst-case scenario (if acceptable) or best-case scenario (if not acceptable). A threshold of unacceptable risk was reached within the range of registered rates for a few species/timing combinations for which both bounds are presented.

DDD = daily dietary dose (mg/kg bw/d) = shortcut value \* rate (kg ac/ha) \* PT 0.5

RAL = regulatory acceptable level = NOEL 1.0 mg/kg bw/d (Breslin et al. 1991)

RQ = risk quotient = DDD/RAL, where acceptable RQ ≤1

Appendix D – Runoff assessments

Assessment scenarios

Runoff has been modelled following the methodology described in Appendix B, Aquatic species of the [APVMA Risk Assessment Manual, Environment](https://apvma.gov.au/node/46416). In order to perform the appropriate high tier calculations, the runoff assessment has been undertaken using the PERAMA[[7]](#footnote-8) software. All runoff calculations assume that 50% of residues intercepted by the foliage are washed off due a rainfall event and contribute to the total soil residue subject to runoff. In addition, it is assumed that no more than 50% of the catchment is treated at once, with a few exceptions as described below.

For ornamentals, it is conservatively assumed that 0.1% of the catchment is treated. This is based on information from the Department of Agriculture, Fisheries and Forestry (DAFF) MCAS-S tool that indicates the maximum fraction of catchment area to nursery production is 0.07% (Victoria).

For crawling insect control, it is assumed that an industrial building has a perimeter of 250 m and a treatment width of 1.0 m (50 cm up wall, 50 cm on ground). Assuming one industrial building is treated at 5,000 g ac/ha in a 10-ha catchment, environmental exposure is equivalent to 13 g ac/ha (i.e. 0.0025% of catchment is treated).

A small fraction of the catchment is also assumed for termite protection. Assuming a perimeter of 250 m (industrial buildings), a diameter of 20 cm (transmission poles) and a barrier of 150 mm wide around each, the treated areas are equivalent to 37.5 m2 per building and 0.26 m2 per pole. Assuming 2 industrial buildings and 16 transmission poles are treated at 100 kg ac/ha in a 10-ha catchment, environmental exposure in the tropics is equivalent to 750 g ac/ha (buildings) and 40 g ac/ha (poles). Assuming all of these structures can be treated within the same 10-ha catchment, this equates to a total of 790 g ac/ha in the tropics (i.e. 0.079% of catchment is treated). Temperature regions would be half this rate.

Table B1: Soil exposure rates assessed for the runoff assessments of chlorpyrifos

| Use pattern | Situation | Application rate and frequency | Foliar interception fraction | Fraction catchment treated | Seasonal catchment exposure rate (g/ha) |
| --- | --- | --- | --- | --- | --- |
| Field crops and pasture | Pasture, lucerne | 2× 350 g ac/ha  7d interval | 0.90 | 0.5 | 177 |
| Sugarcane | 2× 350 g ac/ha  7d interval | 0 | 0.5 | 322 |
| Forage crops, oilseeds (excluding cotton and canola) | 2× 350 g ac/ha  7d interval | 0.30 | 0.5 | 274 |
| Oilseeds (excluding cotton and canola) | 1× 110 g ac/ha | 0.30 | 0.5 | 47 |
| Duboisia | 1× 450 g ac/ha | 0.25 | 0.5 | 197 |
| Tree and vine crops | Avocado, grapevines, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards | 1× 250 g ac/ha | 0.60 | 0.5 | 88 |
|  | Grapevine rootlings | 1× 8000 g ac/ha | 0 | 0.5 | 4000 |
| Vegetable crops | Vegetables (band or broadcast application) | 2× 350 g ac/ha  7d interval | 0.25 | 0.5 | 282 |
|  | Ginger | 1× 450 g ac/ha  1× 92 g ac/ha | 0.25  0.25 | 0.5  0.5 | 197  40 |
| Ornamentals | Potted ornamentals, Tasmanian blue gum planting hole soil | 1× 5000 g ac/ha | 0 | 0.001 | 5.0 |
| Crawling insect control | In and around buildings | 1× 5000 g ac/ha | 0 | 0.0025 | 13 |
| Mosquito control | Vegetation (mosquito adults) | 4× 54 g ac/ha  7d interval | 0.20 | 0.5 | 76 |
| Commercial turf | Worst-case scenario | 2× 500 g ac/ha  7d interval | 0.90 | 0.5 | 253 |
| Termite protection | External perimeter treatment (horizontal or vertical) around large buildings | 1× 1000 kg ac/ha | 0 | 0.00075 | 750 |
|  | New and existing poles | 1× 1000 kg ac/ha | 0 | 0.00004 | 40 |
| Combination products | Subterrannean clover, clover, lucerne | 2× 400 g ac/ha  7d interval | 0.85 | 0.5 | 212 |
| Field tomatoes | 2× 250 g ac/ha  7d interval | 0.25 | 0.5 | 201 |

Risk assessment scenarios as described in section 2; foliar interception values are based on EFSA (2020) defaults for similar situations; seasonal catchment exposure rates based on indicated application rate, frequency, soil DT50 28 days, foliar interception (with 50% wash-off) and fraction of catchments treated.

Tier 1 assessments

The Tier 1 (screening level) is a worst-case scenario where slope is fixed at 8%, which is considered protective of 95% of agricultural activities in Australia. The rainfall value is set at 8 mm, which results in the maximum receiving water concentration using the standard water body of 1 ha and 15 cm initial depth when the clay dominated Queensland soil profile is used; the catchment is 10 ha. Further, for this worst-case scenario, a fallow/bare soil runoff profile is assessed. Acceptable risks could be concluded for ornamentals, crawling insect control and termite pole protection at the Tier 1 level of assessment (Table B2).

Table B2: Tier 1 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

| Situation | Seasonal catchment  exposure rate (g/ha) | Rainfall  (mm) | Slope  (%) | Kf  (mL/g) | Runoff  (mm) | PEC  (µg/L) | RQ |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Potted ornamentals, Tasmanian blue gum planting hole soil | 5.0 | 8.00 | 8.00 | 67 | 1.34 | 0.0091 | 0.09 |
| Crawling insect control in and around buildings | 13 | 8.00 | 8.00 | 67 | 1.34 | 0.024 | 0.24 |
| Treatment of new and existing poles for termite protection | 40 | 8.00 | 8.00 | 67 | 1.34 | 0.073 | 0.73 |

Seasonal catchment exposure rates from Table B1

Tier 2 assessments

Where the assessment fails at Tier 1, a regional assessment (Tier 2) is undertaken as either a state based or tropical/subtropical based assessment depending on the cropping situation and production areas. At this level of assessment, the 90th percentile slope value is applied. The rainfall value used is determined as that required to result in the maximum water concentration using the standard water body (1 ha surface area, 15 cm deep). At this level of assessment, the rainfall value is determined to be that resulting in the maximum water body concentration and reflects the soil profile applied in the modelling, not the actual rainfall pattern of the region being assessed. Runoff risks for a large number of use scenarios could be concluded at the Tier 2 level of assessment as indicated in Table B3.

Acceptable risks could not be determined for external perimeter treatment (horizontal or vertical) around large buildings (Table B4). In-stream analyses cannot be undertaken for urban scenarios; thus, no further refinement can be undertaken and the use pattern is not supported.

Table B3: Tier 2 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

| Region | Seasonal catchment  exposure rate (g/ha) | Rainfall  (mm) | Slope  (%) | Kf  (mL/g) | Runoff  (mm) | PEC  (µg/L) | RQ |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Pasture and lucerne | | | | | | | |
| Queensland and Northern Territory | 177 | 17 | 1.10 | 108 | 2.48 | 0.02 | 0.20 |
| Victoria | 177 | 24 | 3.87 | 108 | 2.78 | 0.06 | 0.65 |
| South Australia | 177 | 25 | 2.87 | 88 | 2.85 | 0.06 | 0.55 |
| Western Australia | 177 | 39 | 3.17 | 108 | 3.35 | 0.04 | 0.37 |
| Sugarcane | | | | | | | |
| Burdekin | 322 | 14 | 1.84 | 108 | 2.20 | 0.07 | 0.74 |
| Forage crops and oilseeds (excluding cotton and canola) | | | | | | | |
| Queensland and Northern Territory | 274 | 19 | 1.97 | 67 | 2.79 | 0.10 | 1.0 |
| New South Wales and ACT | 274 | 27 | 1.89 | 88 | 2.92 | 0.05 | 0.52 |
| Victoria | 274 | 27 | 1.18 | 67 | 2.92 | 0.04 | 0.42 |
| Tasmania | 274 | 21 | 2.59 | 194 | 2.74 | 0.04 | 0.39 |
| South Australia | 274 | 28 | 2.49 | 77 | 2.92 | 0.08 | 0.79 |
| Western Australia | 274 | 44 | 2.46 | 67 | 3.54 | 0.07 | 0.68 |
| Duboisia | | | | | | | |
| Burdekin | 197 | 17 | 1.84 | 108 | 2.39 | 0.04 | 0.38 |
| Mary Burnett | 197 | 17 | 3.59 | 108 | 2.39 | 0.08 | 0.82 |
| SE Queensland | 197 | 17 | 3.88 | 108 | 2.39 | 0.09 | 0.90 |
| Avocado, grapevines, apple, pear, stone fruit, Macrocarpa hedges adjacent to orchards, adult mosquito control | | | | | | | |
| Queensland and Northern Territory | 88 | 17 | 4.27 | 108 | 2.39 | 0.04 | 0.42 |
| New South Wales and ACT | 88 | 27 | 4.27 | 108 | 2.99 | 0.03 | 0.32 |
| Victoria | 88 | 27 | 2.85 | 108 | 2.96 | 0.02 | 0.20 |
| Tasmania | 88 | 20 | 12.39 | 194 | 2.60 | 0.08 | 0.84 |
| South Australia | 88 | 28 | 5.36 | 88 | 2.91 | 0.05 | 0.50 |
| Western Australia | 88 | 46 | 3.78 | 108 | 3.29 | 0.02 | 0.17 |
| Wet tropics | 88 | 17 | 6.84 | 108 | 2.39 | 0.08 | 0.76 |
| Burdekin | 88 | 17 | 1.84 | 108 | 2.39 | 0.02 | 0.16 |
| Mackay Whitsunday | 88 | 17 | 4.64 | 108 | 2.39 | 0.05 | 0.46 |
| Fitzroy | 88 | 17 | 4.35 | 108 | 2.39 | 0.04 | 0.43 |
| Mary Burnett | 88 | 17 | 3.59 | 108 | 2.39 | 0.03 | 0.34 |
| SE Queensland | 88 | 17 | 3.88 | 108 | 2.39 | 0.04 | 0.37 |
| Northern NSW | 88 | 17 | 7.74 | 108 | 2.39 | 0.09 | 0.90 |
| Vegetable crops (band or broadcast application) | | | | | | | |
| Victoria | 282 | 21 | 2.85 | 108 | 2.59 | 0.08 | 0.80 |
| South Australia | 282 | 22 | 2.81 | 88 | 2.66 | 0.10 | 0.96 |
| Western Australia | 282 | 34 | 3.78 | 108 | 3.20 | 0.08 | 0.82 |
| Burdekin | 282 | 14 | 1.84 | 108 | 2.20 | 0.06 | 0.64 |
| Ginger | | | | | | | |
| Burdekin | 197 | 14 | 1.84 | 108 | 2.20 | 0.04 | 0.43 |
| Mary Burnett | 197 | 14 | 3.59 | 108 | 2.20 | 0.09 | 0.93 |
| SE Queensland | 197 | 14 | 3.88 | 108 | 2.20 | 0.10 | 1.0 |
| Commercial turf | | | | | | | |
| Queensland and Northern Territory | 253 | 24 | 4.27 | 108 | 2.98 | 0.06 | 0.57 |
| New South Wales and ACT | 253 | 35 | 4.27 | 108 | 3.07 | 0.04 | 0.40 |
| Victoria | 253 | 35 | 2.85 | 108 | 3.06 | 0.02 | 0.25 |
| South Australia | 253 | 37 | 2.81 | 88 | 3.19 | 0.03 | 0.30 |
| Western Australia | 253 | 57 | 3.78 | 108 | 4.05 | 0.03 | 0.26 |
| Wet tropics | 253 | 24 | 6.84 | 108 | 2.98 | 0.10 | 1.0 |
| Burdekin | 253 | 24 | 1.84 | 108 | 2.98 | 0.02 | 0.21 |
| Mackay Whitsunday | 253 | 24 | 4.64 | 108 | 2.98 | 0.06 | 0.63 |
| Mary Burnett | 253 | 24 | 3.59 | 108 | 2.98 | 0.05 | 0.46 |
| SE Queensland | 253 | 24 | 3.88 | 108 | 2.98 | 0.05 | 0.50 |
| Subterranean clover, clover, lucerne (combination products) | | | | | | | |
| Queensland and Northern Territory | 212 | 17 | 1.97 | 108 | 2.43 | 0.07 | 0.71 |
| New South Wales and ACT | 212 | 26 | 1.89 | 108 | 2.96 | 0.05 | 0.52 |
| Victoria | 212 | 26 | 1.18 | 108 | 2.96 | 0.03 | 0.31 |
| Tasmania | 212 | 20 | 2.59 | 194 | 2.75 | 0.05 | 0.51 |
| South Australia | 212 | 27 | 2.49 | 88 | 2.95 | 0.08 | 0.84 |
| Western Australia | 212 | 42 | 2.46 | 108 | 3.39 | 0.05 | 0.49 |
| Field tomatoes (combination products) | | | | | | | |
| New South Wales and ACT | 201 | 21 | 4.27 | 108 | 2.58 | 0.09 | 0.89 |
| Victoria | 201 | 21 | 2.85 | 108 | 2.59 | 0.06 | 0.55 |
| South Australia | 201 | 22 | 2.81 | 108 | 2.66 | 0.05 | 0.53 |
| Western Australia | 201 | 34 | 3.78 | 108 | 3.20 | 0.06 | 0.57 |
| Burdekin | 201 | 14 | 1.84 | 108 | 2.20 | 0.04 | 0.44 |
| Mary Burnett | 201 | 14 | 3.59 | 108 | 2.20 | 0.09 | 0.95 |
| SE Queensland | 201 | 14 | 3.88 | 108 | 2.20 | 0.10 | 1.0 |

Seasonal catchment exposure rates from Table B1; sugarcane scenario in Burdekin assumes no trash blanket is present

Table B4: Tier 2 scenarios showing unacceptable runoff risks of chlorpyrifos to aquatic species – Termite protection

| Region | Seasonal catchment  exposure rate (g/ha) | Rainfall  (mm) | Slope  (%) | Kf  (mL/g) | Runoff  (mm) | PEC  (µg/L) | RQ |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Queensland and Northern Territory | 790  395 | 7.00  7.00 | 4.02  4.02 | 108  108 | 1.20  1.20 | 0.94  0.46 | 9.4  4.6 |
| New South Wales and ACT | 395 | 9.00 | 4.56 | 108 | 1.51 | 0.51 | 5.1 |
| Victoria | 395 | 9.00 | 4.95 | 108 | 1.53 | 0.57 | 5.7 |
| Tasmania | 395 | 7.00 | 9.50 | 108 | 1.15 | 1.33 | 13 |
| South Australia | 395 | 9.00 | 2.28 | 108 | 1.53 | 0.23 | 2.3 |
| Western Australia | 395 | 14.00 | 2.30 | 108 | 2.16 | 0.20 | 2.0 |

Seasonal catchment exposure rates from Table B1

Tier 3 assessments

This highest tier of assessment applies long term rainfall data for representative weather stations in the different regions, which has been obtained from the Bureau of Meteorology. Further, the receiving water characteristics are based on long term stream flow monitoring data and this tier therefore allows assessments to be undertaken on both spatial and temporal scales.

The high tier assessment approach for runoff has been used for a number of years and through this experience, scope for additional refinements have become apparent. There are 2 areas where significant improvement has been made.

The first relates to fraction of catchment treated at a given time. The current approach in the APVMA manual assumes for in-stream analysis that 20% of a catchment is treated at a given time, and all treated area contributes to runoff. This has been shown to potentially underestimate exposure for some situations such as cereals and pasture, and overestimate exposure for cropping situations where growing occurs over smaller areas such as horticultural crops. The updated MCAS-S data on a 1 km2 scale have been assessed for major land uses and proportions of catchments grown to a particular land use have now been assessed. These values, while stated in MCAS-S as being “Catchment” are probably more appropriate to be considered a basin level so may underestimate exposure in smaller catchments. However, overall, the results are considered applicable as a general indication of the dominance of a particular land use within a catchment scale assessment. In order to identify a fraction of catchment for a particular land use, catchments where ≥90% of the land use in a region was found were used for the analysis. The fraction of catchment was then taken as the 90th percentile value from this range of catchments. This value was lower than the highest catchment but tended to be higher than the majority of catchments. Nonetheless, it is considered sufficiently conservative to include situations where higher contributions in sub-catchment areas are found and these data are not available.

The second area for improvement relates to the time over which the rainfall event is assumed to occur (currently 1 h for the 25th percentile rainfall value and 2 h for the 75th percentile rainfall value). The 25th and 75th rainfall values are based on daily rainfall (24 h) data from different weather stations within the growing regions. These results have now been compared to a 1 in 10 year rainfall intensity for a 24 hour duration to better allocate a duration of the rainfall event being assessed. The rainfall intensity values are obtained from the Intensity Frequency Distribution (IFD) data available from the Bureau of Meteorology (BOM). The coordinates for the town/weather station assessed are used. As an example, in Cairns, the 25th percentile rainfall value in January is 16 mm, and the 1 in 10 year 24 h rainfall intensity is 16.1 mm/h. Therefore, the use of a 1 h duration for this is appropriate. However, in Richmond, Tasmania, the 25th percentile rainfall value in summer is 11.7 mm, and the 1 in 10 year 24 h rainfall intensity is 2.98 mm/h. Therefore, with this intensity, the 25th percentile rain event will occur over a duration of 3.9 hours. This method, while increasing realism, still does not address temporal rainfall trends in the different areas because the BOM value is an annual result irrespective of the time of year the result was obtained. However, this methodology is considered a significant improvement to the modelling in PERAMA.

Acceptable risks could be concluded for all uses in the remaining regions except for grapevine rootlings. Please refer to the tables below for a summary of the critical outcomes.

Table B5: Tier 3 scenarios showing acceptable runoff risks of chlorpyrifos to aquatic species (RAL 0.1 µg/L)

| Region | Slope  (%) | Fraction  catchment  treated | Catchment  exposure  (g/ha) | Timing | Stream  flow  (%) | Rainfall  (mm/d) | Rain  duration  (h) | | Runoff  (%) | | Waters  protected  (%) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Pasture and lucerne | | | | | | | | | | | |
| NSW and ACT | 2.54 | 0.53 | 188 | Summer | 25 | 16.9 | 1.3 | | 0.0025 | | 97 |
| Tasmania | 3.59 | 0.35 | 124 | Summer | 75 | 23.9 | 3.0 | | 0.014 | | >99 |
| Sugarcane | | | | | | | | | | | |
| Wet tropics | | 2.97 | 0.057 | 37 | Mar | 75 | 64.7 | 2.91 | | 0.030 | >99 |
| Mackay Whitsunday | | 2.02 | 0.279 | 180 | Sep | 75 | 31.8 | 1.5 | | 0.009 | 98 |
| Mary Burnett | | 1.56 | 0.092 | 59 | May | 75 | 49.4 | 3.5 | | 0.012 | >99 |
| SE Queensland | | 1.68 | 0.046 | 30 | Jan | 75 | 36.0 | 3.6 | | 0.009 | 97 |
| Northern NSW | | 3.36 | 0.042 | 27 | Jun | 75 | 38.9 | 3.1 | | 0.022 | >99 |
| Duboisia | | | | | | | | | | | |
| Wet tropics | | 2.97 | 0.057 | 22 | Mar | 75 | 64.7 | 2.91 | | 0.031 | >99 |
| Mackay Whitsunday | | 2.02 | 0.279 | 110 | Sep | 25 | 12.2 | 0.6 | | 0.003 | 96 |
| Northern NSW | | 3.36 | 0.042 | 17 | Jun | 75 | 38.9 | 3.1 | | 0.026 | >99 |
| Grapevine rootlings | | | | | | | | | | | |
| NSW and ACT | | 1.85 | 0.076 | 608 | Summer | 25 | 16.9 | 1.3 | | 0.020 | 96 |
| Tasmania | | 5.38 | 0.067 | 536 | Winter | 25 | 11.5 | 1.3 | | 0.0048 | 96 |
| Western Australia | | 1.64 | 0.020 | 160 | Summer | 75 | 27.6 | 2.9 | | 0.0009 | >99 |
| Wet tropics | | 2.97 | 0.057 | 456 | Nov | 25 | 13.7 | 0.62 | | 0.005 | 90 |
| Fitzroy | | 1.89 | 0.007 | 56 | Apr | 75 | 43.4 | 1.9 | | 0.014 | 91 |
| Northern NSW | | 3.36 | 0.042 | 336 | Oct | 75 | 28.1 | 2.2 | | 0.017 | 93 |
| Vegetables (band or broadcast application) | | | | | | | | | | | |
| NSW and ACT | | 1.85 | 0.076 | 43 | Winter | 75 | 45.9 | 2.8 | | 0.012 | >99 |
| Tasmania | | 5.38 | 0.067 | 38 | Summer | 75 | 23.2 | 3.0 | | 0.031 | >99 |
| Wet tropics | | 2.97 | 0.057 | 32 | Nov | 25 | 13.7 | 0.62 | | 0.006 | 99 |
| Mackay Whitsunday | | 2.02 | 0.279 | 157 | Nov | 25 | 12.2 | 0.60 | | 0.003 | 90 |
| Fitzroy | | 1.89 | 0.007 | 3.9 | Apr | 75 | 43.4 | 1.9 | | 0.011 | 98 |
| Mary Burnett | | 1.56 | 0.092 | 52 | May | 75 | 49.4 | 3.5 | | 0.010 | >99 |
| SE Queensland | | 1.68 | 0.046 | 26 | Jan | 75 | 36.0 | 3.6 | | 0.009 | 97 |
| Northern NSW | | 3.36 | 0.042 | 24 | Jun | 75 | 38.9 | 3.1 | | 0.020 | >99 |
| Ginger | | | | | | | | | | | |
| Wet tropics | | 2.97 | 0.057 | 22 | Feb | 75 | 63.7 | 2.85 | | 0.021 | >99 |
| Mackay Whitsunday | | 2.02 | 0.279 | 110 | Aug | 25 | 11.0 | 0.5 | | 0.002 | 95 |
| Fitzroy | | 1.89 | 0.007 | 2.8 | Apr | 75 | 43.4 | 1.9 | | 0.011 | 98 |
| Northern NSW | | 3.36 | 0.042 | 17 | Jun | 75 | 38.9 | 3.1 | | 0.020 | >99 |
| Commercial turf | | | | | | | | | | | |
| Tasmania | | 5.38 | 0.01 | 5.1 | Summer | 75 | 23.2 | 3.0 | | 0.004 | >99 |
| Northern NSW | | 3.36 | 0.01 | 5.1 | Jun | 75 | 38.9 | 2.5 | | 0.006 | >99 |
| Field tomatoes (combination products) | | | | | | | | | | | |
| Tasmania | | 5.38 | 0.067 | 27 | Summer | 75 | 23.2 | 3.0 | | 0.030 | >99 |
| Wet tropics | | 2.97 | 0.057 | 23 | Nov | 25 | 13.7 | 0.62 | | 0.009 | 99 |
| Mackay Whitsunday | | 2.02 | 0.279 | 112 | Aug | 25 | 11.0 | 0.5 | | 0.002 | 95 |
| Fitzroy | | 1.89 | 0.007 | 2.8 | Apr | 75 | 43.4 | 1.9 | | 0.018 | 98 |

Only worst-case scenarios are presented for each region; seasonal catchment exposure rates from Table B1 have been readjusted to account for the refined fractions catchment treated; sugarcane scenarios assume a trash blanket is present; risks are considered acceptable where ≥90% of receiving waters are protected.

Table B6: Regions showing unacceptable runoff risks of chlorpyrifos to aquatic species – Grapevine rootlings

| Region | Slope  (%) | Fraction  catchment  treated | Catchment  exposure  (g/ha) | Timing | Stream  flow  (%) | Rainfall  (mm/d) | Rain  duration  (h) | Runoff  (%) | Waters  protected  (%) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Victoria | 1.24 | 0.092 | 736 | Autumn | 75  25 | 31.7  18.1 | 2.9  1.3 | 0.0048  0.0015 | **96**  **84** |
|  |  |  |  | Spring | 75  25 | 27.7  17.4 | 2.6  1.3 | 0.0039  0.0014 | 97  90 |
|  |  |  |  | Summer | 75  25 | 34.0  19.5 | 3.4  1.4 | 0.0053  0.0019 | **96**  **69** |
|  |  |  |  | Winter | 75  25 | 29.6  17.4 | 2.1  1.2 | 0.0043  0.0014 | 99  94 |
| South Australia | 2.33 | 0.098 | 784 | Autumn | 75  25 | 30.8  18.8 | 3.0  1.4 | 0.0084  0.0026 | **93**  **78** |
|  |  |  |  | Spring | 75  25 | 28.0  19.2 | 2.7  1.3 | 0.0070  0.0028 | **95**  **83** |
|  |  |  |  | Summer | 75  25 | 33.7  19.1 | 3.0  1.3 | 0.0097  0.0027 | **85**  **63** |
|  |  |  |  | Winter | 75  25 | 26.4  17.9 | 2.7  1.3 | 0.0063  0.0022 | 99  92 |
| Burdekin | 0.80 | 0.132 | 1056 | Jan | 25  75 | 16.5  49.5 | 1.0  2.9 | 0.002  0.006 | >99  >99 |
|  |  |  |  | Feb | 25  75 | 15.8  53.4 | 0.9  3.2 | 0.002  0.006 | >99  >99 |
|  |  |  |  | Mar | 25  75 | 14.8  50.0 | 0.9  3.0 | 0.001  0.006 | >99  >99 |
|  |  |  |  | Apr | 25  75 | 13.8  38.6 | 0.8  2.3 | 0.001  0.005 | >99  >99 |
|  |  |  |  | May | 25  75 | 12.4  28.0 | 0.7  1.7 | 0.001  0.004 | >99  >99 |
|  |  |  |  | Jun | 25  75 | 12.7  28.5 | 0.8  1.7 | 0.001  0.004 | >99  >99 |
|  |  |  |  | Jul | 25  75 | 12.6  29.3 | 0.7  1.7 | 0.001  0.004 | 96  >99 |
|  |  |  |  | Aug | 25  75 | 12.7  29.2 | 0.8  1.7 | 0.001  0.004 | 94  >99 |
|  |  |  |  | Sep | 25  75 | 14.6  33.8 | 0.9  2.0 | 0.001  0.004 | **84**  **>99** |
|  |  |  |  | Oct | 25  75 | 12.7  36.1 | 0.8  2.1 | 0.001  0.005 | **72**  **>99** |
|  |  |  |  | Nov | 25  75 | 13.5  32.9 | 0.8  2.0 | 0.001  0.004 | **89**  **>99** |
|  |  |  |  | Dec | 25  75 | 14.4  41.9 | 0.9  2.5 | 0.001  0.005 | >99  >99 |
| Mackay Whitsunday | 2.02 | 0.279 | 2232 | Jan | 25  75 | 14.2  57.8 | 0.7  2.8 | 0.003  0.018 | **83**  **97** |
|  |  |  |  | Feb | 25  75 | 15.8  50.7 | 0.8  2.4 | 0.004  0.016 | 93  99 |
|  |  |  |  | Mar | 25  75 | 16.2  49.2 | 0.8  2.4 | 0.004  0.016 | 94  >99 |
|  |  |  |  | Apr | 25  75 | 13.2  39.1 | 0.6  0.9 | 0.003  0.014 | **88**  **>99** |
|  |  |  |  | May | 25  75 | 11.9  24.0 | 0.6  1.1 | 0.002  0.008 | **84**  **93** |
|  |  |  |  | Jun | 25  75 | 13.7  33.0 | 0.7  1.6 | 0.003  0.012 | **79**  **92** |
|  |  |  |  | Jul | 25  75 | 11.6  31.4 | 0.6  1.5 | 0.002  0.011 | **79**  **88** |
|  |  |  |  | Aug | 25  75 | 11.0  30.0 | 0.5  1.4 | 0.002  0.010 | **72**  **76** |
|  |  |  |  | Sep | 25  75 | 12.2  31.8 | 0.6  1.5 | 0.002  0.011 | **66**  **73** |
|  |  |  |  | Oct | 25  75 | 14.0  23.0 | 0.7  1.1 | 0.003  0.008 | **52**  **71** |
|  |  |  |  | Nov | 25  75 | 12.2  38.2 | 0.6  1.8 | 0.002  0.013 | **53**  **72** |
|  |  |  |  | Dec | 25  75 | 14.0  39.6 | 0.7  1.9 | 0.003  0.014 | **65**  **93** |
| Mary Burnett | 1.56 | 0.092 | 736 | Jan | 25  75 | 13.6  39.5 | 1.0  2.8 | 0.002  0.010 | **97**  **88** |
|  |  |  |  | Feb | 25  75 | 13.8  42.1 | 1.0  3.0 | 0.002  0.011 | >99  97 |
|  |  |  |  | Mar | 25  75 | 13.4  34.1 | 0.9  2.4 | 0.002  0.009 | 96  91 |
|  |  |  |  | Apr | 25  75 | 12.4  31.6 | 0.9  2.2 | 0.002  0.008 | **93**  **84** |
|  |  |  |  | May | 25  75 | 13.2  49.4 | 0.9  3.5 | 0.002  0.012 | **92**  **78** |
|  |  |  |  | Jun | 25  75 | 12.5  33.2 | 0.9  2.4 | 0.002  0.009 | **98**  **89** |
|  |  |  |  | Jul | 25  75 | 17.0  38.7 | 1.2  2.7 | 0.004  0.010 | **92**  **85** |
|  |  |  |  | Aug | 25  75 | 11.8  29.8 | 0.8  2.1 | 0.002  0.008 | **93**  **83** |
|  |  |  |  | Sep | 25  75 | 14.4  32.0 | 1.0  2.3 | 0.008  0.008 | **89**  **81** |
|  |  |  |  | Oct | 25  75 | 14.4  35.0 | 1.0  2.5 | 0.003  0.009 | **80**  **65** |
|  |  |  |  | Nov | 25  75 | 12.4  36.9 | 0.9  2.6 | 0.002  0.010 | **89**  **72** |
|  |  |  |  | Dec | 25  75 | 13.5  38.3 | 1.0  2.7 | 0.002  0.010 | **93**  **79** |
| SE Queensland | 1.68 | 0.046 | 368 | Jan | 25  75 | 14.0  36.0 | 1.4  3.6 | 0.003  0.010 | **89**  **78** |
|  |  |  |  | Feb | 25  75 | 13.8  36.2 | 1.4  3.5 | 0.003  0.010 | **95**  **88** |
|  |  |  |  | Mar | 25  75 | 13.2  32.3 | 1.3  3.2 | 0.002  0.009 | **93**  **86** |
|  |  |  |  | Apr | 25  75 | 12.6  32.5 | 1.3  2.9 | 0.002  0.008 | **93**  **86** |
|  |  |  |  | May | 25  75 | 12.6  32.5 | 1.3  3.3 | 0.002  0.009 | **94**  **86** |
|  |  |  |  | Jun | 25  75 | 12.2  31.8 | 1.2  3.1 | 0.002  0.009 | **96**  **89** |
|  |  |  |  | Jul | 25  75 | 12.7  28.4 | 1.3  2.8 | 0.002  0.008 | 96  91 |
|  |  |  |  | Aug | 25  75 | 11.9  24.0 | 1.2  2.4 | 0.002  0.007 | **95**  **89** |
|  |  |  |  | Sep | 25  75 | 11.5  22.7 | 1.2  2.3 | 0.002  0.006 | **91**  **83** |
|  |  |  |  | Oct | 25  75 | 12.7  28.4 | 1.3  2.8 | 0.002  0.008 | **89**  **75** |
|  |  |  |  | Nov | 25  75 | 12.9  29.5 | 1.3  3.0 | 0.002  0.008 | **91**  **80** |
|  |  |  |  | Dec | 25  75 | 13.3  32.5 | 1.3  3.2 | 0.002  0.009 | **90**  **78** |

Seasonal catchment exposure rates from Table B1 have been readjusted to account for the refined fractions catchment treated; risks are considered acceptable where ≥90% of receiving waters are protected.

Appendix E – PBT and POP assessments

At its 17th meeting, the Persistent Organic Pollutants Review Committee (POPRC) agreed that chlorpyrifos met the screening criteria in Annex D of the Stockholm Convention (decision POPRC-17/4).

Persistence criterion

The Stockholm Convention provides scientifically based criteria for potential POPs and a process that ultimately may lead to elimination of a POP substance globally. The criteria for persistence in Annex D of the convention are expressed as single-media criteria as follows:

1. Evidence that the half-life of the chemical in water is greater than 2 months (60 days), or that its half-life in soil is greater than 6 months (180 days), or that its half-life in sediment is greater than 6 months (180 days); or
2. Evidence that the chemical is otherwise sufficiently persistent to justify its consideration within the scope of the Convention.

In support of meeting persistence criteria, the following information is reported in POPRC-17/4:

1. In the water degradation studies evaluated, DT50 values range from 21 days at 22.5°C to 75 days at 8°C. Chlorpyrifos has shown half-lives in water of greater than 2 months, especially at lower temperatures.

In soil, at application rates for agricultural uses (below 100 mg/kg), the half-lives found span a wide range, from 6 days at 20°C to 224 days at 15°C.

In sediments, the threshold of 6 months is exceeded in some studies performed under anaerobic conditions.

Chlorpyrifos shows higher persistence when associated with sediments and at lower temperatures.

1. Monitoring data from the Arctic demonstrate that chlorpyrifos is sufficiently persistent to be transported to remote regions. Since it is more persistent at lower temperatures, it is expected to persist in these regions for a considerable length of time. Findings of chlorpyrifos in sediment cores in Arctic and sub-Arctic lakes (Landers et al. 2008) that can be dated back several decades provide further evidence of the persistence of chlorpyrifos in sediments.

From data provided to the APVMA, the DT50 of chlorpyrifos in soil exceeds 12 months in many soils with much longer half-lives at higher rates observed. APVMA data does not indicate chlorpyrifos exceeds the persistence criterion for sediment with DT50 values <6 months. Based on information assessed by the POPRC, there is sufficient evidence that chlorpyrifos meets the criterion on persistence.

Bioaccumulation criterion

As noted above, the criteria for bioaccumulation in Annex D of the Stockholm Convention are given as follows:

1. Evidence that the bioconcentration factor or bioaccumulation factor in aquatic species for the chemical is greater than 5000 or, in the absence of such data, that the log Kow is greater than 5;
2. Evidence that a chemical presents other reasons for concern, such as high bioaccumulation in other species, high toxicity or ecotoxicity; or
3. Monitoring data in biota indicating that the bioaccumulation potential of the chemical is sufficient to justify its consideration within the scope of the Convention.

In support of meeting bioaccumulation criteria, the following information is reported in POPRC-17/4:

1. log Pow for chlorpyrifos ranges between 4.7 and 5.2, indicating a potential for bioaccumulation in aquatic organisms. The available bioconcentration factor (BCF) values in fish cover a broad range from 440 to 5,100 in many species, developmental stages and exposure scenarios. Numerous BCF values in fish show a moderate bioconcentration.
2. Chlorpyrifos shows high toxicity in fish and other species, such as invertebrates, amphibians, birds and mammals. In combination with high toxicity, even moderate bioaccumulation can lead to body concentrations that can cause adverse effects.
3. Chlorpyrifos has been found in biota at different trophic levels in remote regions, in apex predators and in human breast milk, which is a concern for offspring.

The APVMA data holdings indicate bioaccumulation criteria are not met with a log Pow of 4.9 and a BCF of 1374 in whole fish. However, taking into account other information reported in the POPRC decision, there is sufficient evidence that chlorpyrifos meets the criterion for bioaccumulation.

Toxicity criterion

For persistent and bioaccumulative substances, exposure may be anticipated to cover the whole life of an organism as well as multiple generations. Consequently, chronic ecotoxicity data, preferably covering impacts on reproduction, are used to establish the toxicity within the PBT context.

As noted, the Stockholm Convention on POPs provides scientifically based criteria for potential POPs and a process that ultimately may lead to elimination of a POP substance globally. The criteria for toxicity in Annex D of the POPs convention do not consist of numerical values, but are given as follows:

1. Evidence of adverse effects to human health or to the environment that justifies consideration of the chemical within the scope of this Convention; or
2. Toxicity or ecotoxicity data that indicate the potential for damage to human health or to the environment.

In support of meeting toxicity/adverse effects criteria, the following information is reported in POPRC-17/4:

The main effect following short- to long-term repeated oral administration of chlorpyrifos is the inhibition of acetylcholinesterase (AchE) activity. There is potential evidence that developmental neurotoxicity effects from chlorpyrifos may occur at doses below those causing cholinesterase inhibition. Several epidemiological studies and reviews from regulatory authorities have associated pre- and postnatal exposure to chlorpyrifos with changes in brain morphology, delays in cognitive and motor functions, problems with attention and tremors. This, in addition to high toxicity to mammals, indicates a potential for damage to human health. Chlorpyrifos shows a high toxicity to aquatic organisms at approximately 0.1 µg/L. Invertebrates, especially crustaceans and insects, are the most sensitive taxa among aquatic organisms. Chlorpyrifos shows high acute toxicity to terrestrial vertebrates, especially to birds (LD50 value of 13.3 mg/kg bw) and to non-target arthropods, especially pollinators. The very high acute and chronic toxicity to a wide range of vertebrates, invertebrates and insects (including bees) indicates a potential for damage to the environment.

There is sufficient evidence that chlorpyrifos meets the criterion on adverse effects. APVMA data holdings confirm this with higher tier (microcosm/mesocosm) data, the consistent finding was a NOEC value of 0.10 µg ac/L for the most sensitive aquatic species.

Potential for long-range environmental transport

The criteria for long-range transport in Annex D of the Stockholm convention are expressed as follows:

1. Measured levels of the chemical in locations distant from the sources of its release that are of potential concern;
2. Monitoring data showing that long-range environmental transport, with the potential for transfer to a receiving environment, (via air, water or migratory species); or
3. Environmental fate properties and/or model results that demonstrate that the chemical has a potential for such transportation, with the potential for transfer to a receiving environment in locations distant from the sources of its release. For a chemical that migrates significantly through the air, its half-life in air should be greater than 2 days.

In support of meeting long range transport potential criteria, the following information is reported in POPRC-17/4:

(2) and (ii) Chlorpyrifos has been widely detected in remote areas far away from point sources and/or agricultural uses, both in abiotic compartments and in biota such as caribou, seals and polar bears in the Arctic, and in sea-ice meltwater and air in Antarctica. In the Bering and Chukchi marine ecosystems, it was found in marine fog, sea water and marine ice. From one study with 5 pesticides analysed, it was the most frequently identified in sea water. It was monitored in snow cores collected over sea ice from 4 north-west Alaskan Arctic estuaries. In a dated ice core from Svalbard, chlorpyrifos was the only pesticide detected continuously, with first detections between 1971 and 1980. Maximum concentrations were detected between 1995 and 2005, which corresponds to the period in which the most recent samples were taken in this study, with the accumulated burden of chlorpyrifos being the highest of all the analysed compounds. Potential routes of transport include atmospheric transport in the gas or particulate phase and transport via water in rivers and ocean currents.

(iii) The half-life of gaseous chlorpyrifos does not exceed 2 days. Particulate chlorpyrifos, however, is more recalcitrant to degradation by hydroxy radical reaction and shows an atmospheric half-life of up to 66.4 hours.

While standard modelling for atmospheric reaction with hydroxyl radicals indicates the persistence of chlorpyrifos in air is not sufficient to meet the long range transport criterion, given measured data in remote areas considered by the POPRC, there is sufficient evidence that chlorpyrifos meets the criterion on potential for long range environmental transport.

Conclusion

Chlorpyrifos met the screening criteria specified in Annex D of the Stockholm Convention on Persistent Organic Pollutants.

Acronyms and abbreviations

| Shortened term | Full term |
| --- | --- |
| AChE | Acetyl cholinesterase |
| ADI | Acceptable daily intake (for humans) |
| APVMA | Australian Pesticides and Veterinary Medicines Authority |
| AF | assessment factor |
| Agvet | Agricultural and veterinary |
| ARfD | Acute reference dose |
| BBCH | Biologische Bundesanstalt, Bundessortenamt and Chemical industry |
| BCF | bioconcentration factor |
| bw | Bodyweight |
| cm | centimetre(s) |
| Codex | Codex Alimentarius Commission |
| CS | capsule suspension |
| CXLs | Codex Maximum Residue Limits |
| d | Day(s) |
| DAR | draft assessment report |
| DCP | 3,6-dichloro-2-pyridinol |
| DES | desethyl-chlopyrifos |
| ds | dry soil |
| DT50 | period required for 50 percent dissipation |
| EC | Emulsifiable concentrate |
| ECX | concentration causing X% effect (ErCx is used for growth rate; EbCx is used for biomass) |
| EFSA | European Food Safety Authority |
| EngC | Engineering controls |
| ERx | rate causing X% effect |
| ESI | Export Slaughter Interval |
| EU | European Union |
| EW | emulsion, oil in water |
| ExpE | exposure estimate |
| g | gram(s) |
| GAP | Good Agricultural Practice |
| h | hour(s) |
| ha | Hectare(s) |
| IPM | Integrated pest management |
| JMPR | Joint Meeting on Pesticide Residues |
| Kf or Kd | (Freundlich) adsorption constant |
| kg | Kilogram(s) |
| Koc or Kfoc | (Freundlich) organic carbon partition coefficient |
| L | litre(s) |
| LCx | lethal concentration to X% of the tested population (LCxcorr is a corrected value to account for bioavailability in the test system) |
| LDX | lethal dose to X% of the tested population |
| LOC | level of concern |
| LOQ | Limit of quantification |
| max | maximum |
| mg | Milligram |
| mL | Millilitre |
| mm | millimetre(s) |
| MOE | Margin of Exposure |
| MRL | Maximum residue limit |
| NEDI | National Estimated Daily Intake |
| NESTI | National Estimated Short-Term Intake |
| nm | nanometre(s) |
| NOEC/NOEL | No observable effect concentration/level |
| NOAEL | No observed adverse effect level |
| NOEC | no observed effect concentration (NOECcorr is a corrected value to account for bioavailability in the test system) |
| NOEL | no observed effect level |
| OC | organic carbon |
| OCS | Office of Chemical Safety within the Australian Government Department of Health |
| OECD | Organization for Economic Co-operation and Development |
| OHS | Occupational health and safety |
| Pa | pascal(s) |
| PBT | persistent – bioaccumulative – toxic |
| PHED | Pesticide Handler Exposure Database |
| PERAMA | Pesticide Environmental Risk Assessment Model for Australia |
| pKa | negative logarithm (to the base 10) of the dissociation constant |
| PMRA | Health Canada’s Pest Management Regulatory Agency |
| Pow | octanol-water partition coefficient |
| PPE | Personal protective equipment |
| ppm | Parts per million |
| POP | persistent organic pollutant |
| POPRC | Persistent Organic Pollutants Review Committee |
| PRF | Preliminary Review Findings |
| PT | proportion of an animal’s daily diet obtained in habitat treated with pesticide |
| RAL | regulatory acceptable level |
| RQ | risk quotient |
| SDRAM | spray drift risk assessment manual |
| SR | Slow-release generator |
| TCP | 3,5,6-trichloropyridinol |
| TMP | 3,5,6-trichloro-2-methoxypyridine |
| TWA | time-weighted average |
| µg | microgram(s) |
| US EPA | United States Environmental Protection Agency |
| UV | ultraviolet |
| VIS | visible |
| WG | water dispersible |
| WP | wettable powder |
| WHO | World Health Organization |
| WHP | Withholding period |

Glossary

|  |  |
| --- | --- |
| Term | Description |
| acceptable daily intake | A level of intake of a chemical (expressed mg/kg bw/day; milligrams per kilogram of body weight per day) that can be ingested daily over an entire lifetime without any appreciable risk to health. |
| acute exposure | Contact between a pesticide and a target occurring over a short time (e.g., less than a day) |
| acute reference dose | The amount of a substance in food or drinking-water, (expressed as mg/kg of body weight), that can be ingested or absorbed over 24 hours or less, without appreciable health risk. |
| acute toxicity | Adverse effects of finite duration occurring within a short time (up to 14 d) after administration of a single dose (or exposure to a given concentration) of a test substance or after multiple doses (exposures), usually within 24 h of a starting point (which may be exposure to the toxicant, or loss of reserve capacity, or developmental change, etc.) |
| active constituent | The substance that is primarily responsible for the effect produced by a chemical product |
| adsorption constant | A measure of the tendency of a chemical to bind to soils |
| adverse effect | Change in the morphology, physiology, growth, development, reproduction or life span of an organism, system, or subpopulation that results in impairment of the capacity to compensate for additional stress, or an increase in susceptibility to other influences |
| aged residue | Residues of a pesticide or its degradates in soil that have diffused into intra-particulate regions following application and have become less accessible to mass transfer and bioabsorption processes, although still amenable to solvent extraction |
| agricultural crop | Any terrestrial plant species grown commercially for food, fibre, foliage, fuel or medicinal production, with the exception of plants that are not part of a crop under management at the time of pesticide application (eg blackberries or volunteer grain plants that have escaped from a cropped area and become weeds in another area). |
| aquatic | Relating to water, as distinct from land or air. |
| assessment factor | reductive factor by which an observed or estimated endpoint of a pesticide is divided to arrive at a regulatory acceptable level |
| bioaccumulation | Progressive increase in the amount of a substance in an organism or part of an organism that occurs because the rate of intake exceeds the organism’s ability to remove the substance from the body |
| bioconcentration | Uptake of a pesticide residue from an environmental matrix, usually through partitioning across body surfaces to a concentration in the organism that is usually higher than in the environmental matrix |
| bioconcentration factor | Ratio between the concentration of pesticide in an organism or tissue and the concentration in the environmental matrix (usually water) at apparent equilibrium during the uptake phase |
| bound residue | Residue associated with one or more classes of endogenous macromolecules that cannot be disassociated by extraction or digestion without alteration |
| buffer zone | An area where pesticide application does not occur between the application site and an identified sensitive area which is downwind from the application site. For boom and aerial spraying, a buffer zone is measured from the edge of the sprayer swath closest to the downwind sensitive area; for vertical spraying, a buffer zone is measured from half a row width (ie trees, vines, other plants) outside the application site closest to the downwind sensitive area. |
| capsule suspension | A stable suspension of capsules in a fluid normally intended for dilution with water before use |
| catchment | Landform that collects precipitation and retains it in an impoundment or drains it through a single outlet. |
| chronic exposure | Continued or intermittent long-term contact between an agent and a target |
| chronic toxicity | Adverse effects following chronic exposure |
| concentration | Amount of a material, agent (e.g., pesticide) dissolved or contained in unit quantity in a given medium or system |
| degradate | Chemical that is formed when a substance breaks down |
| dissipation | Loss of pesticide residues from an environmental compartment due to degradation and transfer to another environmental compartment |
| dissociation constant | The ratio of concentration of dissociated ions to the concentration of original acid |
| dose | Total amount of a pesticide or agent administered to, taken up or absorbed by an organism, system, or (sub-) population |
| effect assessment | Combination of analysis and inference of possible consequences of the exposure to a pesticide based on knowledge of the dose–effect relationship associated with that agent in a specific target organism, system, or (sub-) population |
| emergence | The event in seedling establishment when a shoot becomes visible by pushing through the soil surface |
| emulsifiable concentrate | A liquid, homogenous preparation to be applied as an emulsion after dilution in water |
| emulsion, oil in water | A fluid, heterogeneous preparation consisting of a dispersion of fine globules of pesticide in an organic liquid in a continuous water phase |
| endpoint | Measurable ecological or toxicological characteristic or parameter of the test system that is chosen as the most relevant assessment criterion |
| environmental fate | Destiny of a pesticide or chemical after release to the environment involving considerations such as transport through air, soil, or water, bioconcentration, degradation, etc. |
| environmental risk | probability that an adverse effect on humans an environmental system/receptor will be observed for a given exposure to a pesticide based on the probability of that exposure and the sensitivity of the system/receptor |
| exposure | Concentration or amount of a particular substance that is taken in by an individual, population or ecosystem in a specific frequency over a certain amount of time. |
| exposure assessment | Evaluation of the exposure of an organism, system, or (sub-) population to a pesticide or agent (and its derivatives) |
| Freundlich isotherm | Empirical relationship describing the adsorption of a solute from a liquid or gaseous phase to a solid in which the quantity of material adsorbed per unit mass of adsorbent is expressed as a function of the equilibrium concentration of the sorbate |
| good laboratory practice | The formalized process and conditions under which laboratory studies on pesticides are planned, performed, monitored, recorded, reported, and audited. Studies performed under GLP are based on the national regulations of a country and are designed to assure the reliability and integrity of the studies and associated data |
| half-life | The time taken for the reactant concentration to fall to one-half its initial value |
| hazard | Inherent property of a pesticide having the potential to cause adverse effects when an organism, system, or (sub-) population is exposed to that agent or situation |
| Henry's law constant | A gas law that states the amount of gas absorbed by a given volume of liquid at a given temperature is directly proportional to the partial pressure of that gas in equilibrium with that liquid. As such it provides an indication of the preference of a chemical for air relative to water i.e. its volatility |
| hydrolysis | Chemical decomposition induced by water |
| indicator species | Species whose presence shows the occurrence of defined environmental conditions |
| intake | Process by which a pesticide or agent crosses an outer exposure surface of a target without passing an absorption barrier, i.e., through ingestion or inhalation |
| integrated pest management | Use of pest and environmental information in conjunction with available pest control technologies to prevent unacceptable levels of pest damage by the most economical means and with the least possible hazard to persons, property, and the environment |
| larva | Recently hatched insect, fish, or other organism that has different physical characteristics than those seen in the adult, requiring metamorphosis to reach the adult body structure. |
| leaching | Downward movement of pesticides into a soil profile with soil water |
| metabolite | Substance formed as a consequence of metabolism in an organism |
| microcosm or mesocosm | Man-made study system containing associated organism and abiotic components that is large enough to be representative of a natural ecosystem, yet small enough to be experimentally manipulated. Microcosms are generally smaller indoor systems; mesocosms are larger outdoor systems. |
| mineralisation | Conversion of an element from an organic form to an inorganic form. Mineralisation of pesticides most commonly refers to the microbial degradation to carbon dioxide as a terminal metabolite |
| no observed effect level | Greatest concentration or amount of a substance, found by experiment or observation, which causes no detectable adverse alteration of morphology, functional capacity, growth, development, or life span of the target organism under defined conditions of exposure |
| non-target species | Organisms that are not the intended targets of a particular use of a pesticide. |
| organophosphorus pesticide | Generic term for pesticides containing phosphorus but commonly used to refer to insecticides consisting of acetylcholinesterase inhibiting esters of phosphate or thiophosphate |
| partition coefficient | log Pow is the logarithm (base-10) of the partition coefficient between n-octanol and water |
| persistence | Residence time of a chemical species (pesticide and/or metabolites) subjected to degradation or physical removal in a soil, crop, animal, or other defined environmental compartment |
| photolysis | Chemical decomposition induced by light or other radiant energy |
| regulatory acceptable level | Criterion or standard that is considered safe or without appreciable risk |
| runoff | Transport of water and soil from the surface of an agricultural field to a non-target area such as a stream due to a precipitation event |
| solubility in water | The mass of a given substance (the solute) that can dissolve in a given volume of water |
| surface water | All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors which are directly influenced by surface water |
| technical material | Commercial grade of the pesticide as it comes from the manufacturing plant comprising the active ingredient and associated impurities. It may also contain small quantities of additives necessary for stability. |
| terrestrial | Relating to land, as distinct from water or air. |
| vapour pressure | The pressure at which a liquid is in equilibrium with its vapour at a given temperature. It is a measure of the tendency of a material to vaporise. The higher the vapour pressure the greater the potential. |
| volatilisation | Evaporation of pesticides during and after application |
| water dispersible | A preparation granule consisting of granules to be applied after disintegration and dispersion in water |
| watercourse | A river, creek or other natural watercourse (whether modified or not) in which water is contained or flows (whether permanently or from time to time); and includes:   * a dam or reservoir that collects water flowing in a watercourse * a lake or ‘wetland’ through which water flows * a channel into which the water of a watercourse has been diverted * part of a watercourse   An estuary through which water flows. |
| wetland | An area of land where water covers the soil—all year or just at certain times of the year. They include:   * swamps, marshes * billabongs, lakes, lagoons * saltmarshes, mudflats * mangroves, coral reefs * bogs, fens, and peatlands.   A ‘wetland’ may be natural or artificial and its water may be static or flowing, fresh, brackish or saline. |

References

Abu A, 2015a. Aerobic soil degradation kinetic assessment of chlorpyrifos and its metabolites TCP and TMP. Report no. 150806

Abu A 2015b. Aerobic soil degradation kinetic assessment of 3,6-dichloro-2-pyridinol (DCP). Report no. 150939

Abu A, 2015c. Degradation kinetic assessment of chlorpyrifos and its metabolite TCP in field soils. Report no. 150805

Abu A, 2015d. Aerobic water-sediment degradation kinetic assessment of chlorpyrifos and its metabolite TCP. Report no. 150804

Adema DMM, 1990. The toxicity of Dursban F to *Salmo gairdneri* in a prolonged toxicity test (21 days). Report no. R89/415

Adema DMM, de Ruiter A, 1990. The chronic toxicity of Dursban F to *Daphnia magna*. Report no. R89/231

Anand HS, 2016a. Hydrolysis as a function of pH of chlorpyrifos technical. Report no. G9546

Anand HS, 2016b. Direct photolysis of chlorpyrifos technical. Report no. G9547

APVMA 2000a, *Chlorpyrifos interim review report: Agricultural assessment*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/14741](https://apvma.gov.au/node/14741)

APVMA 2000b, *Chlorpyrifos interim review report: Chemistry assessment*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/19616](https://apvma.gov.au/node/19616)

APVMA 2000c, *Chlorpyrifos interim review report: Environmental assessment*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/14756](https://apvma.gov.au/node/14756)

APVMA 2000d, *Chlorpyrifos interim review report: Occupational health and safety assessment*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/14751](https://apvma.gov.au/node/14751)

APVMA 2000e, *Chlorpyrifos interim review report: Summary*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/14736](https://apvma.gov.au/node/14736)

APVMA 2000f, *Chlorpyrifos interim review report: Toxicology assessment*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/14746](https://apvma.gov.au/node/14746)

APVMA 2009, *Chlorpyrifos preliminary review findings report on additional residues data*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/14761](https://apvma.gov.au/node/14761)

APVMA 2017, *Reconsideration of chlorpyrifos: Supplementary toxicology assessment report*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/26831](https://apvma.gov.au/node/26831)

APVMA 2019a, *Reconsideration of chlorpyrifos: 2019 Toxicology Update*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/50111](https://apvma.gov.au/node/50111)

APVMA 2019b, *Reconsideration of chlorpyrifos: 2019 Worker and Residential Exposure and Risk Characterization Update*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/50121](https://apvma.gov.au/node/50121)

APVMA 2019c, *Reconsideration of chlorpyrifos: Supplementary environment assessment report*, Australian Pesticides and Veterinary Medicines Authority, Canberra, available at [apvma.gov.au/node/50116](https://apvma.gov.au/node/50116)

Bakker FM, 2000. Effects of Dursban 75 WG on honeybees *Apis mellifera* L when applied to flowering *Phacelia tanacetifolia* 1, 3, 5, 7 and 14 days before exposure determined in a cage test. Report no. DA012AMS

Bakker FM, 2002. Effects of Reldan 22 and Dursban 75 WG on honeybees *Apis mellifera* L when applied at different times determined in a cage test. Report no. DA013AMS

Baloch R, Hund K, 1990. Effect of Dursban 4 on the activity of soil microflora – short-term respiration, nitrogen mineralisation. Report no. GHE-P-2206

Baloch R, Todt K, 1990. Investigation of the effect of Dursban 4 on soil microflora using the dehydrogenase and nitrification tests. Report no. GHE-P-2207

Baumgartner D, 2009. 2,3,5-trichloro-6-methoxypyridine: determination of effects on soil microflora activity. Report no. 090108

Beavers JB, Fink R, 1978a. Chlorpyrifos: one-generation reproduction study – bobwhite quail. Report no. 103-177

Beavers JB, Fink R, 1978b. Chlorpyrifos: one-generation reproduction study – mallard duck. Report no. 103-178

Bell G, 1993. EF 1042 (Dursban 480): acute toxicity to honey bees (*Apis mellifera*). Report no. DWC-664/931497

Bell G, 1994. Dursban F (chlorpyrifos): acute toxicity to honey bees (*Apis mellifera*). Report no. DWC-705b/942785

Bergfield A, 2011a. Lorsban Advanced (GF-2153 450 g as/L EW): effects on the seedling emergence of non-target terrestrial plants (tier I). Report no. 110081

Bergfield A, 2011b. Lorsban Advanced (GF-2153 450 g as/L EW): effects on the vegetative vigour of non-target terrestrial plants (tier I). Report no. 110080

Bergfield A, 2012a. Lorsban Advanced (GF-2153 450 g as/L EW): effects on the seedling emergence and growth of non-target terrestrial plants (tier II). Report no. 110794

Bergfield A, 2012b. Lorsban Advanced (GF-2153 450 g as/L EW): effects on the vegetative vigour of non-target terrestrial plant, onion (*Allium cepa*) (tier II). Report no. 110793

Biester MA, 2010. 2,3,5-trichloro-6-methoxypyridine: growth inhibition test with *Pseudokirchneriella subcapitata* (syn. *Selenastrum capricornutum*) under static conditions. Report no. 90104

Bopanna MS, 2014a. Chlorpyrifos technical: fish acute toxicity test with common carp. Report no. G9559

Bopanna MS, 2014b. Chlorpyrifos technical: *Daphnia magna* acute immobolization test. Report no. G9558

Bopanna MS, 2014c. Chlorpyrifos technical: alga growth inhibition test. Report no. G9557

Bopanna MS, 2014d. Chlorpyrifos technical: earthworm acute toxicity test. Report no. G9561

Bowmann JH, 1988. Acute flow-through toxicity of chlorpyrifos to rainbow trout (*Salmo gairdneri*). Report no. R-5231

Breslin WJ, Liberacki AB, Dittenber DA, Brzak KA, Quast JF 1991, *Chlorpyrifos: Two-generation dietary reproduction study in Sprague-Dawley rats,* Report No. K-044793-088 Toxicology Research Laboratory, Dow Chemical Co., Midland, Michigan, USA (Dow AgroSciences).

Brown RP, Hugo JM, Miller JA, Harrington CK, 1997. Chlorpyrifos: acute toxicity to the amphipod (*Hyalella azteca*). Report no. 971095

Brown K, Stamp G, Kitson J, 2007. Refinement of the risk to birds following application of chlorpyrifos to vines in southern France. Report no. 61074

Brown KC, 1991. The effects of Dursban 4 and Reldan 50 EC on beneficial arthropods in apple orchards. Report no. 91-03

Brown KC, 1993. The effects of Dursban 4 on predatory epigeal arthropods in grassland. Report no. 93-06

Brüll LP, Donath-Van Scholl I, de Vette HQM, Heim LG, 2002. Investigation into the identity of an unknown metabolite formed during an aerobic soil degradation study using 3,5,6-trichloro-2-pyridinol. Report no. K18A

Bull AD, Cameron DM, 2013. Chlorpyrifos technical: acute oral toxicity (LD50) to the bobwhite quail. Report no. 2019993

Burgess D, 1988. Acute flow-through toxicity of chlorpyrifos to *Daphnia magna*. Report no. R-5230

Campbell S, Hoxter KA, Jaber M, 1990. 3,5,6-trichloro-2-pyridinol: an acute toxicity study with the northern bobwhite. Report no. 103-347

Candolfi MP, 1995. CHA 7110 (chlorpyrifos 480 g/L EC): 14-day acute toxicity test with the earthworm (*Eisenia foetida*). Report no. CHA-20-CYF

Clark B, 2013. The environmental fate of the 3,5,6-trichloro-2-pyridinol (TCP) metabolite as generated in the aerobic degradation of chlorpyrifos in four soils. Report no. 120571

Coady KK, Lehman CM, Hutchinson KL, Marino TA, Malowinski NA, Thomas J, 2012. Chlorpyrifos: amphibian metamorphosis assay using African clawed frog (*Xenopus laevis*). Report no. 101127

Coady KK, Louch DW, Holzheuer WB, McFadden LG, 2015. Chlorpyrifos: a modified fish short-term reproduction assay using the fathead minnow *Pimephales promelas*. Report no. 150048

Comb AL, 2001. Determination of partition coefficient for 3,5,6-trichloro-2-pyridinol. Report no. NAFST471

Comb AL, 2002. Determination of vapour pressure for 3,5,6-trichloro-2-methoxypyridine. Report no. NAFST577

Currie RJ, Louch DW, Coady KK, Fiting JA, Marino TA, Perala AW, Sosinski LK, Thomas J, 2011. Chlorpyrifos: fish short-term reproduction assay using fathead minnow (*Pimephales promelas*). Report no. 101123

Curtis-Jackson P, Gassen M, 2015. Aerobic mineralisation of 14C-chlorpyrifos in surface water – simulation biodegradation test. Report no. 130539

Daam MA, Crum SJ, van den Brink PJ, Nogueira AJ, 2008. Fate and effects of the insecticide chlorpyrifos in outdoor plankton-dominated microcosms in Thailand. Environmental Toxicology and Chemistry 27(12): 2530-2538

Damon A, Heim LG, 2001. Adsorption and desorption of 14C-chlorpyrifos to five European soils. Report no. 111207

Damon A, Sarff P, 2001. Adsorption and desorption of 14C-3,5,6-trichloro-2-pyridinol to five European soils. Report no. 85187

Day SR, Rüdel H, 1993. The persistence of chlorpyrifos in air and its evaporation behaviour from soil and leaf surfaces following application of Dursban 480 (EF1042) - Germany 1992. Report no. GHE-P-2966

de Vette HQM, Schoonmade JA, 2001a. A study on the route and rate of aerobic degradation of 14C-chlorpyrifos in four European soils. Report no. 84333

de Vette HQM, Schoonmade JA, 2001b. A study on the route and rate of aerobic degradation of 14C-TCP (3,5,6-trichloropyridinol) in four European soils. Report no. 84334

Dittrich R, Staedtler T, 2010. Chlorpyrifos in citrus orchards – field study on the status of bird communities and reproductive performance. Report no. R10187

Douglas MT, Bell IB, 1985a. The acute toxicity of chlorpyrifos to ide (*Leuciscus idus*). Report no. 441B/85605

Douglas MT, Bell IB, 1985b. The acute toxicity of chlorpyrifos to roach (*Rutilus rutilus*). Report no. 441A/85604

Douglas MT, Pell IB, 1985. Assessment of ready biodegradabilty of chlorpyrifos, chlorpyrifos-methyl, cyhextain and DOWCO 439. Report no. GHE-P-1394

Douglas MT, Halls RWS, McDonald IA, 1990. The algistatic activity of Dursban F technical. 538/891942

Dow 2010[a], Comparison of cholinesterase (che) inhibition in young adult and preweanling CD rats after acute and repeated chlorpyrifos or chlorpyrifos-oxon exposures. The Dow Chemical Company Study ID 091107, pp 1–1062.

Durando J, 2005. 3,5,6-trichloro-2-pyridinol (TCP): acute oral toxicity up and down procedure in rats. Report no. 50254

EFSA (European Food Safety Authority), 2009. Guidance document on risk assessment for birds & mammals on request from EFSA. EFSA Journal 7(12): 1438. <https://doi.org/10.2903/j.efsa.2009.1438>

EFSA (European Food Safety Authority), 2020. Scientific report of EFSA on the ‘repair action’ of the FOCUS surface water scenarios. EFSA Journal 18(6):6119, 301 pp. <https://doi.org/10.2903/j.efsa.2020.6119>

FAO 2020, FAO Specifications And Evaluations For Agricultural Pesticides. Chlorpyrifos. *O,O*-diethyl *O*-3,5,6-trichloro-2-pyridyl phosphorothioate. Food and Agriculture Organization of the United Nations, available at [fao.org/3/ca8091en/ca8091en.pdf](https://www.fao.org/3/ca8091en/ca8091en.pdf).

Farnsworth B 2001, Application of Pyritilene Blue Bag Banana Bunch Bags for the sampling of bags and fruit for residue analysis, One Trial, Innisfail, Queensland, Australia. Report Number KOOR/0006/1.

Farnsworth B 2001a, Application of Pyritilene Blue Bag Banana Bunch Bags for the sampling of bags and fruit for residue analysis, One Trial, Wamuran (Toowoomba), Queensland, Australia. Report Number KOOR/0007a/1.

Fontaine DD, Wetters JH, Weseloh JW, Stockdale GD, Young JR, Swanson ME, 1987. Field dissipation and leaching of chlorpyrifos. Report no. GHC-1957

Gallagher SP, Beavers JB, 2007. Chlorpyrifos technical: a single dietary exposure with the northern bobwhite. Report no. 60364

Gallagher SP, Beavers JB, Jaber MJ, 1996. Chlorpyrifos technical: an acute oral toxicity study with the house sparrow. Report no. DECO-ES-3133

Ganßmann M, 2015. 3,6-dichloro-2-pyridinol: effects on reproduction and growth of earthworms *Eisenia fetida* in artificial soil with 10% peat. Report no. 150363

Giddings JM, 1993. Chlorpyrifos (Lorsban 4E): outdoor aquatic microcosm test for environmental fate and ecological effects of combinations of spray and slurry treatments. Report no. 92-11-4486

Giddings JM, 2011. Invertebrate communities in outdoor microcosms treated with chlorpyrifos: reanalysis of data reported in Giddings 1992. Report no. 101879

Goodman LR, Hansen DJ, Middaugh DP, Cripe GM, Moore JC, 1985. Method for early life-stage toxicity tests using three artherinid fishes and results with chlorpyrifos. Aquatic Toxicology and Hazard Assessment ASTM STP 854: 145-154

Gorzinski SJ, Mayes MA, Ormand JR, Weinberg JT, Richardson CH, 1991a. 3,5,6-trichloro-2-pyridinol: acute 96-hour toxicity to the rainbow trout *Oncorhynchus mykiss* Walbaum. Report no. ES-DR-0037-0423-8

Gorzinski SJ, Mayes MA, Ormand JR, Weinberg JT, Richardson CH, 1991b. 3,5,6-trichloro-2-pyridinol: acute 96-hour toxicity to the bluegill *Lepomis macrochirus* Rafinesque. Report no. ES-DR-0037-0423-7

Gorzinski SJ, Mayes MA, Ormand JR, Weinberg JT, Richardson CH, 1991c. 3,5,6-trichloro-2-pyridinol: acute 48-hour toxicity to the water flea *Daphnia magna* Straus. Report no. ES-DR-0037-0423-5

Grant M, McLachlan T, 2015. 14C-3,6-dichloro-2-pyridinol: adsorption properties in five soils. Report no. 141093

Graves WG, Smith GJ, 1991. 3,5,6-trichloro-2-pyridinol: a 96-hour flow-through acute toxicity test with the Atlantic silverside *Menidia menidia*. Report no. ES-DR-0037-0423-9

Hamitou M, 2010a. 2,3,5-trichloro-6-methoxypyridine: acute toxicity to rainbow trout (*Oncorhynchus mykiss*) under semi-static conditions. Report no. 090102

Hamitou M, 2010b. 2,3,5-trichloro-6-methoxypyridine: acute toxicity to water fleas (*Daphnia magna*) under static conditions. Report no. 090103

Hansen SC, Woodburn KB, Ball T, Wilga PC, 1992. Chlorpyrifos: distribution and metabolism in the eastern oyster *Crassostrea virginica*. Report no. DECO-ES-2377

Havens PL, Kieatiwong S, Shepler K, 1992. The photochemical degradation of chlorpyrifos on soil by natural sunlight. Report no. 90075

Hayward JC, 2002. Effects of Dursban 480 EC on reproduction and growth of the earthworm *Eisenia fetida*. Report no. CEMS-1719

Heim LG, Damon A, 2001. Adsorption and desorption of 14C-3,5,6-trichloro-2-methoxypyridine to five European soils. Report no. 111111

Henck JW, Kociba RJ, 1980. Three samples of Dursban insecticide: acute oral toxicity and acute percutaneous absorption potential

Hoberg JR, 2005. 3,6-dichloro-2-pyridinol: acute toxicity to water fleas Daphnia magna under static conditions. Report no. 50273

Hoberg JR, 2006. 3,6-dichloro-2-pyridinol: growth inhibition test with freshwater diatom (*Navicula pelliculosa*). Report no. 50272

Hoffmann S, 2009. 2,3,5-trichloro-6-methoxypyridine: a 14-day acute toxicity test with the earthworm *Eisenia fetida* (Oligochaeta: Lumbricidae). Report no. 90107

Hudson RH, Tucker RK, Haegele MA, 1972. Effect of age on sensitivity: acute oral toxicity of 14 pesticides to mallard ducks of several ages. Toxicology and Applied Pharmacology 22: 556-561

Hudson RH, Tucker RK, Haegele MA, 1984, Handbook of toxicity of pesticides to wildlife. US Department of the Interior, Fish and Wildlife Service Resource publications, Washington DC

Ilamurugan G, 2011. Acute oral toxicity study in rats with chlorpyrifos tech. Report no. 1820

Jackson R, 2015. Evaluation of degradation kinetics of chlorpyrifos and its metabolites in anaerobic soil. Report no. 150705

Jarvinen AW, Tanner DK, 1982. Toxicity of selected controlled release and corresponding unformulated technical grade pesticides to the fathead minnow *Pimephales promelas*. Environmental Pollution Series A, Ecological and Biological 27(3): 179-195

JMPR 2000, Pesticide residues in food: 2000: Evaluations Part 1 - Residues, Joint Meeting of the FAO Panel of Experts on Pesticides Residues in Food and the Environment and the WHO Expert Group on Pesticide Residues, Geneva, Switzerland, 20-29 September 2000, FAO, Plant Production and Protection Paper 165.

Johnson AJ, 1993. EF1042 (Dursban 480): acute toxicity (LC50) to the earthworm (*Eisenia foetida*). Report no. 654/930785

Kang S, 2014a. Anaerobic metabolism of 14C-chlorpyrifos in four soils. Report no. 130581

Kang S, 2014b. Anaerobic soil metabolism of 14C-chlorpyrifos-methyl. Report no. 130579

Kang S, 2015. Aerobic aquatic metabolism of 14C-chlorpyrifos. Report no. 2024648

Karambelkar NP, 2011a. Determination of vapour pressure of chlorpyrifos technical 98%. Report no. PCP1070

Karambelkar NP, 2011b. Determination of solubility of chlorpyrifos technical 98% in water. Report no. PCP1071

Kirk HD, Gilles MM, Hugo JM, McFadden LG, 1999. Effect of 3,5,6-trichloro-2-pyridinol (TCP) on the growth of the freshwater green alga *Selenastrum capricornutum* Printz. Report no. 991194

Kirk HD, Gilles MM, McClymont EL, 2000a. 3,5,6-trichloro-2-pyridinol (TCP): growth inhibition test with the bluegreen alga *Anabaena flos-aquae*. Report no. 001149

Kirk HD, Gilles MM, McClymont EL, McFadden LG, Staley JL, 2000b. 3,5,6-trichloro-2-pyridinol (TCP): growth inhibition test with the freshwater aquatic plant, duckweed *Lemna gibba*. Report no. DECO-HET K-038278-045

Kisicki JC, Seip CW, Combs ML 1999, *A rising dose toxicology study to determine the no-observable-effect-levels (NOEL) for erythrocyte acetylcholinesterase (AChE) inhibition and cholinergic signs and symptoms of chlorpyrifos at three dose levels,* Dow Agrosciences, Report No. DR#K-044793-284.

Kumar SBM, 2014. Chlorpyrifos technical: acute oral toxicity study (acute toxic class method) in Wistar rats. Report no. G9549

Landers DH, Simonich SL, Jaffe DA, Geiser LH, Campbell DH, Schwindt AR, Schreck CB, Kent ML, Hafner WD, Taylor HE, Hageman KJ, Usenko S, Ackerman LK, Schrlau JE, Rose NL, Blett TF, Erway MM, 2008. The fate, transport, and ecological impacts of airborne contaminants in western national parks (USA). EPA/600/R-07/138. U.S. Environmental Protection Agency, Office of Research and Development, NHEERL, Western Ecology Division, Corvallis, Oregon

Lloyd D, Grimes J, Jaber M, 1989a. G01003 chlorpyrifos: an acute oral study with the bobwhite. Report no. 265-104

Lloyd D, Grimes J, Jaber M, 1989b. G01014 chlorpyrifos: an acute oral study with the bobwhite. Report no. 265-105

Long RD, Hoxter KA, Jaber M, 1990. 3,5,6-trichloro-2-pyridinol: a dietary LC50 study with the mallard. Report no. 103-346

López-Mancisidor P, 2015. Review of the effects of chlorpyrifos on freshwater organism on the basis of aquatic higher tier studies (micro- and mesocosms) . Report no. 01879

López-Mancisidor P, Carbonell G, Fernández C, Tarazona JV, 2008. Ecological impact of repeated applications of chlorpyrifos on zooplankton community in mesocosms under Mediterranean conditions. Ecotoxicology 17(8): 811-825

Lu MX, Jiang WW, Wang JL, Jian Q, Shen Y, Liu XJ, Yu XY, 2014. Persistence and dissipation of chlorpyrifos in *Brassica chinensis*, lettuce, celery, asparagus lettuce, eggplant, and pepper in a greenhouse. PLoS ONE 9(6): e100556. doi:10.1371/journal.pone.0100556

Machado MW, 2003. Triclopyr metabolite 3,5,6-TCP: full life-cycle toxicity test with water fleas *Daphnia magna* under static-renewal conditions. Report no. 21300

Madsen S, Humfleet BJ, 2004. MS, IR, NMR and UV/vis spectral analysis of 2-methoxy-3,5,6-trichloropyridine. Report no. AGR132047

Mallett MJ, 2003. The effects of 3,5,6-trichloro-2-pyridinol on reproduction and growth in the earthworm *Eisenia fetida*. Report no. 31063

Mallett MJ, Hayward JC, 1999. A laboratory assessment of the effects of 3,5,6-trichloro-2-pyridinol on soil microflora respiration and nitrogen transformation. Report no. CEMS-1151

Marino TA, Gilles MM, Rick DL, Henry KS, 1999. Evaluation of the toxicity of 3,5,6-trichloro-2-pyridinol (TCP) to the early life stages of the rainbow trout *Oncorhynchus mykiss* Walbaum. Report no. 991173

Marty MS, Andrus AK, Bell MP, Passage JK, Perala AW, Brzak KA, Bartels MJ, Beck MJ, Juberg DR 2012, Cholinesterase inhibition and toxicokinetics in immature and adult rats after acute or repeated exposures to chlorpyrifos or chlorpyrifos-oxon, *Regul Toxicol Pharmacol,* 2012 Jul; 63(2):209–24, doi: 10.1016/j.yrtph.2012.03.015, Epub 2012 Apr 7, PubMed PMID: 22504667.

Mayes MA, Weinberg JT, Rick DL, Martin MD, 1993. Chlorpyrifos: a life-cycle toxicity test with the fathead minnow *Pimephales promelas* Rafinesque. Report no. ES-DR-0043-4946-9

McCall PJ, 1986. Hydrolysis of chlorpyrifos in dilute aqueous solution. Report no. GS-1287

McGibbon A, Frevert J, Schönborn W, 1989. The effect of Dursban 4 on soil microorganisms. Report no. GHE-P-2016

McMinn WR, 1995. CHA7110 (chlorpyrifos 480 g/L EC): acute toxicity to rainbow trout (*Oncorhynchus mykiss*) under flow-through conditions. Report no. CHA-18-CYF

Meikle RW, Hamaker JW, 1981. The physical properties of 3,5,6-trichloro-2-pyridinol (Dowco 463X) and some environmental consequences. Report no. GS-1706

Meikle RW, Youngson CR, 1977. The hydrolysis rate of chlorpyrifos, O,O-diethyl-O-(3,5,6-trichloro-2-pyridyl)phosphorothioate, and its dimethyl analog chlorpyrifos-methyl in dilute aqueous solution. Report no. GS-1522

Mineau P, 2002. Estimating the probability of bird mortality from pesticide sprays on the basis of the field study record. Environmental Toxicology and Chemistry 21(7): 1497-1506

Miyazaki S, Hodgson GC, 1972. Chronic toxicity of Dursban and its metabolite 3,5,6-trichloro-2-pyridinol in chickens. Toxicology and Applied Pharmacology 23: 391-398

Moosmayer P, Wilkens S, 2008. Chlorpyrifos (Dursban 480 EC) in brassica crops - field study on exposure and effects on wild birds. Report no. 71044

Moreth L, 1992. Effects of pesticides on *Aleochara bilineata*: expanded laboratory tests. Report no. Ab-21-9108-I

Murphy PG, Luteske NE, 1986. Bioconcentration of chlorpyrifos in rainbow trout (*Salmo gairdneri* Richardson). Report no. ES-DR-0043-4946-5

Northern Zone, 2021. Pesticide risk assessment for birds and mammals. Selection of relevant species and development of standard scenarios for higher tier risk assessment in the Northern Zone in accordance with Regulation EC 1107/2009. Version 2.1

Odemer R, 2015. Chlorpyrifos: toxicity to honeybee (*Apis mellifera* L.) larvae after acute exposure under in vitro laboratory conditions. Report no. 140806

OECD 2016. OECD guidance document on crop field trials - second addition. Series on pesticides no. 66 and series on testing and assessment no. 164, Paris. Available at <https://one.oecd.org/document/ENV/JM/MONO(2011)50/REV1/en/pdf>.

Old J, 2002a. The dissipation of chlorpyrifos and its major metabolite (3,5,6-trichloro-2-pyridinol) in soil following a single spring application of Dursban 4 (EF-1042), UK 2000. Report no. 104623

Old J, 2002b. The dissipation of chlorpyrifos and its major metabolite (3,5,6-trichloro-2-pyridinol) in soil following a single spring application of Dursban 4 (EF-1042), France 2000. Report no. 104622

Old J, 2002c. The dissipation of chlorpyrifos and its major metabolite (3,5,6-trichloro-2-pyridinol) in soil following a single autumn application of Dursban 4 (EF-1042), Greece 2000. Report no. 104621

Old J, 2002d. The dissipation of chlorpyrifos and its major metabolite (3,5,6-trichloro-2-pyridinol) in soil following a single application of Dursban 4 (EF-1042), Spain 2000. Report no. 103577

Pandya H, 2008. Acute oral toxicity study of chlorpyrifos technical in rats. Report no. 7567

Patel MR, 2015. Acute oral toxicity study of chlorpyrifos TGAI in rats. Report no. 141233

Paterson EA, Toft A, 2007a. Evaluation of the pre-emergence phytotoxicity of three chlorpyrifos-ethyl formulations in a herbicide screen. Report no. GHE-P-11629

Paterson EA, Toft A, 2007b. Evaluation of the post-emergence phytotoxicity of three Dursban (chlorpyrifos-ethyl) formulations in a herbicide screen. Report no. GHE-P-11630

POPRC-17/4: Chlorpyrifos. The Persistent Organic Pollutants Review Committed. Available at <https://chm.pops.int/TheConvention/POPsReviewCommittee/Recommendations/tabid/243/Default.aspx>

Putt AE, 2005. 3,6-dichloro-2-pyridinol: chironomid toxicity test with midge (*Chironomus riparius*) under static conditions using spiked water. Report no. 50274

Quirós-Alcalá, L., Bradman, A., Nishioka, M. et al. 2011. Pesticides in house dust from urban and farmworker households in California: an observational measurement study. *Environ Health 10, 19*. https://doi.org/10.1186/1476-069X-10-19. available at [ehjournal.biomedcentral.com/articles/10.1186/1476-069X-10-19/tables/2](https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-10-19/tables/2)

Racke KD, Lubinski RN, 1992. Sorption of 3,5,6-trichloro-2-pyridinol in four soils. Report no. ENV91081

Roberts NL, Phillips CNK, 1987. The dietary toxicity (LC50) of chlorpyrifos to the mallard duck. Report no. 26/871179

Rodgers MH, 1994. Chlorpyrifos (Dursban FE): acute toxicity (LC50) to the earthworm (*Eisenia foetida*). Report no. 711/942865

Rodgers MH, 1996. Acute oral toxicity (LD50) to the bobwhite quail. Report no. 52/951158

Ross F, 2015. Rate of degradation of 3,6-dichloro-2-pyridinol under aerobic laboratory conditions in four soils at 20°C. Report no. 2029709

Roulin S, 2002. Determination of the water solubility of 3,5,6-trichloro-2-pyrifinol (TCP). Report no. GHE-P-9491

Sabourin PJ, South NL, 2002a. Determination of the water solubility of 3,5,6-trichloro-2-methoxy-pyridine. Report no. NAFST567

Sabourin PJ, South NL, 2002b. Determination of partition coefficient for 3,5,6-trichloro-2-methoxy-pyridine. Report no. NAFST568

Sayers LE, 2003. 3,5,6-trichloro-2-pyridinol (3,5,6-TCP): acute toxicity to the freshwater diatom (*Navicula pelliculosa*). Report no. 31088

Schafer EW, Brunton RB, 1971. Chemicals as bird repellents: two promising agents. Journal of Wildlife Management 35(3): 569-572

Schafer EW, Brunton RB, 1979. Indicator bird species for toxicity determinations is the technique usable in test method development? Special Technical Publication, ASTM, Philadephia, pp. 157-168

Selbach A, Wilkens S, 2008. Chlorpyrifos (Dursban 75 WG) in citrus - field study on exposure and effects on wild birds. Report no. 71048

Sewell IG, Grant-Salmon D, 1993. The acute toxicity of Pyrinex ME to rainbow trout (*Oncorhynchus mykiss*). Report no. R-7188

Sharma HK, 2008a. Acute oral toxicity study of chlorpyrifos technical in Japanese quail. Report no. 8390

Sharma HK, 2008b. Acute oral toxicity test of chlorpyrifos technical in honey bees *Apis mellifera*. Report no. 8391

Shepler K, Racke KD, Concha M. 1994. Photodegradation of 3,5,6-trichloro-2-pyridinol on soil by natural sunlight. Report no. ENV94027

Sherman M, Herrick RB, Ross E, Chang MTY, 1967. Further studies on the acute and sub-acute toxicity of insecticides to chicks. Toxicol Appl Pharmacol 11: 49-67

Shubha SM, 2014a. Determination of partition coefficient (n-octanol/ water) of chlorpyrifos technical by HPLC method. Report no. G9543

Shubha SM, 2014b. Determination of dissociation constant(s) of chlorpyrifos technical in water. Report no. G9537

Shubha SM, 2014c. UV-VIS absorption spectra of chlorpyrifos technical. Report no. G9534

Shubha SM, 2015a. Determination of vapour pressure of chlorpyrifos technical. Report no. G9541

Shubha SM, 2015b. Determination of water solubility of chlorpyrifos technical. Report no. G9542

Simon K, 2001. Estimation of photochemical oxidative degradation of chlorpyrifos and 3,5,6-trichloropyridinol. Report no. 85591

Singh SK, 2009. UV-visible analysis of chlorpyrifos technical. Report no. 8935

Smith GJ, 1987. Pesticide use and toxicology in relation to wildlife: organophosphorus and carbamate compounds. US Department of the Interior, Fish and Wildlife Service Resource publications, Washington DC

Stevenson GT, 1963. An LD50 toxicity study of Dursban in leghorn chickens. Report no. 00095286

Suratwala TG, 2009. Partition coefficient (n-octanol/ water) of chlorpyrifos technical. Report no. 8934

Suresh CS, 2014. Chlorpyrifos technical: acute oral toxicity test in honey bees. Report no. G9562

Suresh CS, 2015. Chlorpyrifos technical: acute contact toxicity test in honey bees. Report no. G9563

Surprenant DC, 1989a. Acute toxicity of chlorpyrifos technical to sheepshead minnow (*Cyprinodon variegatus*) under flow-through conditions. Report no. R-5536

Surprenant DC, 1989b. Acute toxicity of chlorpyrifos technical to mysid shrimp (*Mysidopsis bahia*) under flow-through conditions. Report no. R-5538

Surprenant DC, 1989c. Acute toxicity of chlorpyrifos to eastern oysters (*Crassostrea virginica*) under flow-through conditions. Report no. R-5537

Suryawanshi DS, 2008. Acute oral toxicity study of chlorpyrifos technical in rat. Report no. 8380

Sved D, Drottar KR, Swigert J, Smith GJ, 1993. Chlorpyrifos: a flow-through life-cycle toxicity test with the saltwater mysid (*Mysidopsis bahia*). Report no. ES-2506

Szabo JR, Young JT, Granjean M 1988, *Chlorpyrifos: 13-week dietary toxicity study in Fisher 344 rats,* Report No. TexasT: K-044793-071 Lake Jackson Research Center, Health and Environmental Sciences, Freeport, Texas, USA (Dow AgroSciences).

Tanneberger C, 2015. 3,6-dichloro-2-pyridinol: toxicity to the fathead minnow *Pimephales promelas* under laboratory conditions (acute toxicity test – static). Report no. 150293

Thacker JD, Strauss KA, Smith GJ, 1992. Chlorpyrifos: a bioconcentration test with the eastern oyster (*Crassostrea virginica*). Report no. ES-DR-0043-4946-8

Thomas JD, Phadke KG, 1991. Residual toxicity of chlorpyrifos, quinalphos and oxydemetonmethyl against the grubs and adults of *Coccinella septempunctata* L predating on aphids infesting rapeseed Crop. Ind J Ent 53: 405-511

Tozer RS 1996a, Chlorpyrifos and diazinon residues in the tissues of cattle following treatment with Warrior™ cattle insecticidal ear tags, Flychem Pty Ltd, Trial Report RES 38/96 (I)

Tozer RS 1996b, A study of residues in milk taken from lactating dairy cattle after treatment with Warrior cattle insecticidal ear tags, Flychem Pty Ltd, Trial Report RES 38/96 (II)

Tozer RS 1996c, A study of residues from various organs and tissues of beef cattle after treatment with Warrior cattle insecticidal ear tags, Flychem Pty Ltd, Trial Report RES 38/96 (III)

Tozer RS 1998, Milk residue study #2 Lactating dairy cattle treated with warrior insecticidal cattle ear tags at two tags per animal, Flychem Pty Ltd, Study identification AU 98-38

US EPA 2020a, *US EPA* *Office of Pesticide Programs Occupational Handler Exposure Calculator*, available at [epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data#calculator](https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-handler-exposure-data#calculator)

US EPA 2020b, *US EPA Occupational Pesticide Re-entry Exposure Calculator*, available at [epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-post-application-exposure](https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/occupational-pesticide-post-application-exposure)

van den Brink PJ, van Wijngaarden RPA, Lucassen WGH, Brock TCM, Leeuwangh P, 1996. Effects of the insecticide Dursban 4E (active ingredient chlorpyrifos) in outdoor experimental ditches: II. invertebrate community responses and recovery. Environ Toxicol Chem 15: 1143-1153

van der Kolk J, 1995a. CHA 7110 (chlorpyrifos 480 g/L EC): 48-hour acute toxicity to daphnids (*Daphnia magna*) under static renewal conditions. Report no. 22-CYF

van der Kolk J, 1995b. CHA 7110 (chlorpyrifos 480 g/L EC): static acute toxicity test with the freshwater green algae (*Selenastrum capricornutum*). Report no. 19-CYF

van Wijngaarden RPA, Brock TC, Douglas MT, 2005. Effects of chlorpyrifos in freshwater model ecosystems: the influence of experimental conditions on ecotoxicological thresholds. Pest Management Science 61(10): 923-935

Verma R, 2013a. Acute oral toxicity study of TMP (2,3,5-trichloro-6-methoxypyridine) in rats. Report no. 130506

Verma R, 2013b. Acute oral toxicity study of chlorpyrifos TGAI in mice. Report no. 130940

Verma R, 2015. Acute oral toxicity study of 3,6-DCP metabolite in rats. Report no. 150278

Vinall S, 2011a. Determination of toxicity of TCP metabolite (3,5,6-TCP) of triclopyr on the predatory mite *Hypoaspis aculeifer* (Acari, Laelapidae). Report no. 110184

Vinall S, 2011b. Determination of toxicity of TCP metabolite (3,5,6-TCP) of triclopyr on the springtail *Folsomia candida* (Collembola, Isotomidae). Report no. 110185

Vohra HY, 2009a. Vapour pressure of chlorpyrifos technical. Report no. 8933

Vohra HY, 2009b. Water solubility of chlorpyrifos technical. Report no. 8932

Ward TJ, Boeri RL, 1999. 3,5,6-trichloro-2-pyridinol (TCP): acute toxicity to the earthworm *Eisenia fetida*. Report no. 990149

Watson PA, 2002. 3,5,6-trichloro-2-pyridinol (TCP): calculation of Henry's law constant (H). Report no. GHE-P-9748

Wilkens S, Frese I, Schneider K, 2008a. Chlorpyrifos (Dursban 480 EC): residues of chlorpyrifos in invertebrates after spray application of Dursban 75 DP in citrus orchards - magnitude and time course of residue decline. Report no. 71050

Wilkens S, Frese I, Schwarz J, 2008b. Chlorpyrifos (Dursban 75 WG) in pome fruit orchards - field study on exposure and effects on wild birds. Report no. 71053

Wolf C, Riffel M, Weyman G, Douglas M, Norman S, 2010. Telemetry-based field studies for assessment of acute and short-term risk to birds from spray application of chlorpyrifos. Environ Toxicol Chem 29(8): 1795-1803

Yogeesh BS, 2014. Chlorpyrifos technical: avian acute oral toxicity study in Japanese quails. Report no. G9564

Young JT, Grandjean M 1988, *Chlorpyrifos: 2 year dietary chronic toxicity-oncogenicity study in Fischer 344 rats*, Report No. K-044793-079 Lake Jackson Research Center, Dow Chemical Co., Freeport, Texas, USA (Dow AgroSciences).

1. The Pesticide Manual, British Crop Production Council, 18th edition, 2016. [↑](#footnote-ref-2)
2. JMPR Periodic Review Evaluation for Chlorpyrifos, Joint Meeting on Pesticide Residues, FAO/WHO, 2000 ([fao.org/fileadmin/templates/agphome/documents/Pests\_Pesticides/JMPR/Evaluation00/1CONTENTS.pdf](http://www.fao.org/fileadmin/templates/agphome/documents/Pests_Pesticides/JMPR/Evaluation00/1CONTENTS.pdf)) and references therein. [↑](#footnote-ref-3)
3. FAO Specifications for Chlorpyrifos, FAO 2020 ([fao.org/3/ca8091en/ca8091en.pdf](https://www.fao.org/3/ca8091en/ca8091en.pdf)) [↑](#footnote-ref-4)
4. Not required for ear tags, banana bags, or hides/skins situations [↑](#footnote-ref-5)
5. Not required for ear tags, banana bags, or hides/skins situations [↑](#footnote-ref-6)
6. Not required for ear tags, banana bags, hides/skins, mosquito larvae control, crawling insect control (including ant nests and trails) or termiticides [↑](#footnote-ref-7)
7. © Australian Environment Agency Pty Ltd 2023 [↑](#footnote-ref-8)