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OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

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MEMORANDUM

SUBJECT: **Chlormequat Chloride:** Draft Ecological Risk Assessment for Registration Review

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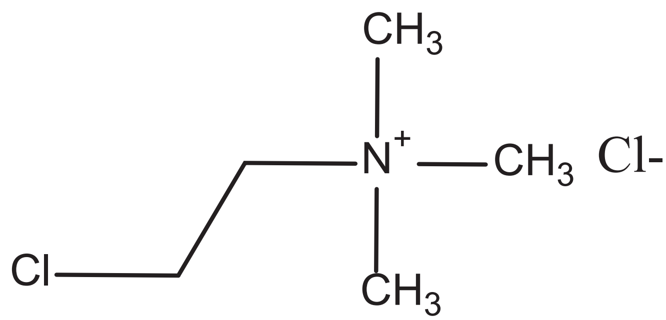
The Environmental Fate and Effects Division (EFED) has completed the draft environmental fate and ecological risk assessment in support of the Registration Review of the chlormequat chloride.

Draft Ecological Risk Assessment for the Registration Review of Chlormequat Chloride



Chlormequat Chloride; CAS No. 999-81-5
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1 Executive Summary

1.1 Overview

This Draft Risk Assessment (DRA) examines the potential ecological risks associated with labeled uses of chlormequat chloride on non-listed non-target organisms. The Residues of Concern (ROC) include only the parent compound. Estimated Environmental Concentrations (EECs) were compared to the toxicity endpoints of parent chlormequat chloride.

Chlormequat chloride is the salt of a quarternary ammonium cation. It is used as a plant-growth regulator and is registered for use only on ornamental plants grown in greenhouses, nurseries, and shadehouses. Outdoor use, such as in shadehouses, is restricted to foliar treatment of containerized ornamentals. It is not applied to ornamentals planted in the field. Chlormequat chloride is registered for use on a variety of ornamentals including herbaceous and woody annual and perennial plants.

1.2 Risk Conclusions Summary

Table 1-1 summarizes potential risks associated with the registered labeled uses of chlormequat chloride. The Residues of Concern (ROC) include only the parent compound. Because chlormequat chloride is applied outdoors only to potted plants, there is a limited exposure pathway for aquatic risk due to the use pattern. The aquatic exposure component of the ecological risk associated with the use of chlormequat chloride was determined using standard modeling scenarios for nursery use. While the shadehouse use is considered an outdoor use, because plants are only treated in pots and chlormequat is not directly applied to field grown plants in the ground, exposure estimates for aquatic risk may overestimate potential aquatic exposures. When Estimated Environmental Concentrations (EECs) are compared to the measured toxicity endpoints for chlormequat chloride, risk quotients (RQ) do not exceed either the acute or chronic risk to non-listed species Level of Concern (LOC) of 0.5 and 1, respectively for aquatic vertebrates and invertebrates. Risk estimates are also below the LOC of 1 for risk to aquatic plants. Sediment risk was not assessed because the octanol-water partition coefficient (K_{ow}) and organic-carbon normalized soil-water distribution coefficient (K_{oc}) values are below threshold values for these parameters, indicating that sediment exposure is not a primary pathway of concern.

Risk to terrestrial vertebrates was assessed based on 9 applications of either the maximum single label application rate of 3.7 lbs ai/A or the maximum extrapolated (to a per-acre basis) spot treatment application rate of 8.24 lbs ai/A following a re-application interval of 5 days. Based on the maximum extrapolated rate of 8.24 lbs ai/A, dietary-based RQs (2-32) exceed the chronic risk LOC for birds feeding on all food types assessed. Acute risk LOC is also exceeded by both dietary- and dose-based RQs for birds feeding on short grass, tall grass, broadleaf plants and arthropods. Based on the maximum single label application rate of 3.7 lbs ai/A, dose-based

RQs (<0.1-15) exceed the acute risk LOC for birds feeding on short grass, tall grass, broadleaf plants, fruit/pods and arthropods; dietary-based RQs (0.9-14) exceed chronic risk for birds feeding on short grass, tall grass, broadleaf plants and arthropods. Using the lowest-observed adverse effect concentration (LOAEC) to calculate the RQ instead of the no-observed adverse effect concentration (NOAEC) still results in chronic risk LOC exceedances for birds. The LOAEC is based on a 5% reduction in survival (*i.e*., the ratio of 14-day hatchlings to number hatched). Since birds serve as surrogates for reptiles and terrestrial-phase amphibians, concerns regarding acute and chronic risk to birds apply to these taxa as well.

For mammals, dose-based RQs (<0.1-11) exceed the acute risk LOC of 0.5 for all-sized mammals feeding on short grass, tall grass, broadleaf plants and arthropods based on the maximum extrapolated rate of 8.24 lbs ai/A. Dose-based RQs (0.4-62) exceed the chronic risk LOC of 1 for all-sized mammals foraging on short grass, tall grass, broadleaf plants, fruit/pods and arthropods. Based on the maximum single label application rate of 3.7 lbs ai/A, dose-based RQs (<0.1-5.0) exceed the acute risk LOC for all-sized mammals feeding on short grass, tall grass, broadleaf plants and arthropods; RQs (0.2-28) exceed chronic risk LOC for all-sized mammals foraging on short grass, tall grass, broadleaf plants and arthropods. Dietary-based RQs (0.2-3.2) exceed the chronic risk LOC for short grass, tall grass, broadleaf plants and arthropods. Using the LOAEC at which there were 9-24% reductions in body weights and a 34% reduction in mean litter size to calculate the RQ instead of the NOAEC still results in chronic risk LOC exceedances for mammals. This indicates a potential risk to mammals exposed to chlormequat chloride at either the maximum single rate or the maximum extrapolated rate of 8.24 lbs. It should be noted that nurseries are typically highly managed areas in which alternative forage/habitat is intentionally limited; therefore such routes of exposure may be limited. However, exposure to food items cannot be totally ruled out for mammals and birds where residues left on seeds, grasses and arthropods that can still serve as food sources for terrestrial vertebrates.

For adult honey bees (*Apis mellifera*), RQs for contact and oral exposure are below the acute risk LOC of 0.4. At the extrapolated application rate of 8.24 lbs ai/A, the chronic RQ (4.1) for adult bees exceeds the chronic risk LOC of 1 based on a NOAEL above which there was a 41% increase in mortality. The chronic RQ (45) for larval honey bees exceeds the chronic risk LOC based on a NOAEC above which there was a 15% reduction in adult bee emergence. Even at the single application rate of 3.7 lbs ai/A, chronic RQ values for adults and larvae are 1.9 and 20, respectively, and exceed the chronic risk LOC. Even at the maximum label rate of 3.7 lbs ai/A, chronic RQ values for adults and larvae are 1.9 and 20, respectively, and exceed the chronic risk LOC. Therefore, there is a potential for chronic risk to both larval and adult honey bees from exposure to chlormequat chloride in the nursery or shadehouse. Since honey bees serve as surrogates for solitary and social non-*Apis* bees, these risk concerns extend to these species of bees. Although chlormequat chloride is a plant growth regulator that is applied to plants before bloom, the compound is systemic in plants and could be translocated to pollen/nectar and serve as a route of exposure for bees in the treatment area. The extent to which bees may be able to access plants in shadehouses and greenhouses may be limited; however, containerized plants in outdoor nurseries with unrestricted access could serve as route of exposure for bees.

Based on the most sensitive monocotyledonous (monocot) and dicotyledonous (dicot) terrestrial plants, RQs exceed the LOC of 1 for risk to terrestrial plants in semi-aquatic areas with non-definitive RQ values of <2.6 and <2.5 for monocots and dicots, respectively. However, based on the most sensitive monocots and dicots and an application rate of 3.7 lbs ai/A, RQs (<1.1) only exceeds the LOC of 1 for risk to dicot terrestrial plants in semi-aquatic areas. It should be noted that these RQs are calculated using EECs based on residues from off-site exposure via spray drift and/or run-off to non-target plants found near application sites. However, since exposure to non-target terrestrial plants in nurseries and shadehouses via spray drift and/or run-off is likely to be limited by the controlled spraying of targeted plants in containers, these RQs may be overestimating risk to terrestrial plants. However, if exposed, there is a likelihood that terrestrial plants will be adversely affected from the registered use of chlormequat chloride. This is consistent with chlormequat chloride being a plant growth regulator.

Since backpack sprayer applications are considered controlled and directed, off-site transport resulting from this application is not considered a major exposure pathway for the current use of chlormequat chloride. Therefore, off-site spray drift distances were not estimated in this assessment.

1.3 Environmental Fate and Exposure Summary

The database for chlormequat chloride is complete and includes new metabolism studies which used exhaustive extraction methods, reducing some of the uncertainty identified in previous assessments related to unextracted residues and allowing them to now be excluded as Residues of Concern (ROC) for risk assessment. Chlormequat chloride is a quarternary ammonium compound that is highly soluble in water and is nonvolatile from soil and water. It is expected to be somewhat mobile in some soils based on measured soil-water distribution coefficient (K_d) values. Thus, it is susceptible to both leaching and runoff in the environment if it reaches the soil on the ground. It is not expected to be significantly transported in the environment through spray drift given the application pattern. Outdoor applications are restricted to containerized ornamentals, so this type of application directly to the foliage of potted plants should also limit its exposure potential in the environment in terms of leaching or runoff; there are no registered uses for application to plants grown in the field. Additionally, the potted plants are removed and replaced with a new set of plants for a total of three crop production cycles a year, maximum.

Chlormequat chloride is stable to hydrolysis and photolysis in water. The parent compound is slowly transformed through microbial metabolism to bound residues and carbon dioxide, but is considered persistent in soils based on the degradation half-lives of approximately 6-9 months in aerobic soils from the U.S. In general, it is transformed via microbial metabolism more slowly in aquatic systems than in soils, with laboratory half-lives of over a year to multiple years (essentially stable) under anaerobic conditions and half-lives of approximately 2 months to over a year in aerobic conditions. There were no major degradates identified in laboratory studies. Unextracted residues in laboratory studies were present at up to 15% in soils and 38% in sediments and are considered bound residues for the purpose of risk assessment.

Bioconcentration data were not submitted (and were not requested for Registration Review) but the compound is not expected to bioconcentrate based on its log K_{ow}. Field dissipation data are not available nor were they requested for the sole registered outdoor use of chlormequat chloride on containerized ornamentals.

Surface water aquatic exposure modeling was simulated using the Pesticide in Water Calculator (PWC version 2.001). The acute (daily average) EEC was 1,828 µg/L, while the 21-day and 60-day EECs were 1,837 and 1,843 µg/L, respectively. However, the aquatic exposure modeling was conducted using nine applications per year to ornamentals in the field which is conservative since chlormequat is applied to containerized pots in shadehouses and not to plants grown in the field limiting the amount transported to the water body by spray drift. Also, potted plants are removed from production after a maximum of three treatments. Additionally, treatment is targeted only to plant foliage and is performed outside (in the shadehouses) only with backpack or handheld sprayers, limiting the amount of chlormequat that will reach the ground or the soil in the pots.

1.4 Ecological Effects Summary

Various studies with terrestrial and aquatic plants and animals exposed to either the technical grade active ingredient (TGAI) or typical end-use (formulated) product (TEP) have been received since the preliminary Problem Formulation was issued in 2016 (USEPA, 2016*a*). Some of these new data provide more sensitive toxicity endpoints than were previously assessed for chlormequat chloride. In general, these new studies have improved the Environmental Protection Agency's (EPA) EFED's understanding of the effects of chlormequat chloride on terrestrial organisms.

With non-definitive LC_{50} values of >1,000,000 µg ai/L and >100,000 µg ai/L, respectively, chlormequat chloride is classified as practically non-toxic to freshwater and estuarine/marine (E/M) fish on an acute exposure basis. Since freshwater fish serve as surrogates for aquatic-phase amphibians, chlormequat chloride is classified as practically non-toxic on an acute exposure basis to aquatic-phase amphibians as well. Chronic exposure to chlormequat chloride resulted in no significant effect on either freshwater (NOAEC = 10,000 µg ai/L; LOAEC > 10,000 µg ai/L) or estuarine/marine (E/M) fish (NOAEC = 9,150 µg ai/L; LOAEC > 9,150 µg ai/L) at the highest concentrations tested.

Chlormequat chloride is classified as slightly toxic to both freshwater invertebrates (EC_{50}=16,900 µg ai/L) and E/M invertebrates (IC_{50}=50,000 µg ai/L), but practically non-toxic to the E/M Mysid Shrimp (LC_{50}= 110,000 µg ai/L) on an acute exposure basis. Chronic exposure of chlormequat chloride to freshwater invertebrate resulted in a 20% reduction in live offspring (NOAEC = 5,000 µg ai/L; LOAEC = 10,000 µg ai/L; but had no lethal or sublethal effects on E/M invertebrates (NOAEC = 9,260 µg ai/L) up to the highest concentration tested (LOAEC > 9,260 µg ai/L).

A 72-h exposure of chlormequat chloride TGAI to aquatic non-vascular plants, resulted in NOAEC and EC_{50} values of 207,000 and >207,000 µg ai/L, respectively. A 7-day toxicity study with aquatic vascular plants resulted in a 16% reduction in frond number (NOAEC = 40; EC_{50} = 2,600 µg ai/L). A 72-h exposure of non-vascular green algae to chlormequat chloride TEP resulted in NOAEC and EC_{50} values of 233,000 and >899,000 µg ai/L, respectively, based on a 12% reduction in plant biomass at the highest concentration tested (LOAEC of 899,000 µg ai/L).

With an LD_{50} of 556 mg a.i./kg bw, chlormequat chloride TGAI is classified as slightly toxic to birds on an acute oral exposure basis and is no more than slightly toxic to birds (LC_{50}>3,175 mg ai/kg diet) on a subacute dietary exposure basis. Since birds serve as surrogates for reptiles and terrestrial-phase amphibians, the toxicity classifications for birds apply to these taxa as well. Chronic exposure of birds to chlormequat chloride resulted in a 5% reduction in the ratio of the number of 14-day survivors to the number of eggs hatched for upland game birds (NOAEC = 390; LOAEC = 658 mg/kg diet).

Chlormequat chloride is moderately toxic (LD_{50}=487 mg ai/kg bw) to rats on an acute oral exposure basis. In a two-generation study with rats, chlormequat chloride exposure resulted in 9-24% decreases in body weights and 34% decrease in mean litter size (NOAEL = 86.4 mg ai/kg bw; LOAEL = 255 mg ai/kg bw).

Chlormequat chloride TGAI is practically non-toxic to adult honey bees on both an acute contact (LD_{50}>0.10 mg ai/bee) and oral (LD_{50}>0.10 mg ai/bee) exposure basis. It is practically non-toxic to honey bee larvae on acute oral exposure basis (LD_{50}>0.091 mg ai/larva). Chronic exposure results in a 15% reduction in adult emergence for larvae at the LOAEL of 0.0083 mg ai/larva/day (NOAEL=0.0025 mg ai/larva/day) and a 41% increase in mortality for adult honey bees at the LOAEL of 0.139 mg ai/bee/day (NOAEL=0.064 mg ai/bee/day).

Exposure of terrestrial plants to chlormequat chloride TEP (Manipulator™; 57% ai) in a seedling emergence study resulted in a 12% reduction in plant height for monocot species (NOAEC = 1.2 lbs ai/A; IC_{25} >2.6 lbs ai/A) and a 20% reduction in height for dicot plants (NOAEC = 0.68 lbs ai/L; IC_{25} = 1.7 lb ai/A). Exposure of terrestrial plants to TEP Manipulator™ in a vegetative vigor test resulted in a 6% reduction in height for monocots (NOAEC =0.38 lbs ai/A; IC_{25} >3.0 lbs ai/A) and a 19% reduction in height for dicots (NOAEC = 1.5 lbs ai/A; and IC_{25} >3.0 lbs ai/A). However, in vegetative vigor studies with the TEP BAS 062 03 W (63.3% ai), the most sensitive dicot had an IC_{25} of 1.5 lbs ai/A and a non-definitive NOAEC of <0.21 lbs ai/A; whereas, monocots were not affected up to the highest application rate tested, *i.e.*, NOAEC=3.4 lbs ai/A and IC_{25}>3.4 lbs ai/A.

1.5 Identification of Data Needs

The environmental fate database is complete for the single registered use on nursery plants in greenhouses and shadehouses. Data from a vegetative vigor study with TEP BAS 062 03 W tested on sunflower at concentrations of ≤0.21 lbs a.i./A will have to be submitted to completely assess the effect of the TEP on terrestrial plants.

Table 1-1. Summary of Risk Quotients for Taxonomic Groups from Current Use of Chlormequat Chloride.

Taxa	Exposure Duration	Risk Quotient (RQ) Range[1]	RQ Exceeding the LOC for Non-listed Species	Additional Information/ Lines of Evidence
Freshwater Fish	Acute	Not calculated	No	No effects observed during exposure to chlormequat chloride.
	Chronic	Not Calculated	No	Toxicity endpoints are non-definitive with no significant effects up to the highest tested concentrations; endpoints are at least 5 times higher than the highest surface water Estimated Environmental Concentration (EEC).
Estuarine/ Marine Fish	Acute	Not calculated	No	No effects observed during exposure to chlormequat chloride.
	Chronic	Not calculated	No	Toxicity endpoints are non-definitive with no significant effects up to the highest tested concentrations; endpoints are at least 5 times higher than the highest surface water EEC.
Freshwater Invertebrates (Water-Column Exposure)	Acute	0.1	No	--
	Chronic	0.4	No	--
Estuarine/ Marine Invertebrates (Water-Column Exposure)	Acute	<0.1	No	--
	Chronic	Not calculated	No	Toxicity endpoints are non-definitive with no significant effects up to the highest tested concentrations; endpoints are at least 5 times higher than the highest surface water EEC.
Freshwater and Estuarine/ Marine Invertebrates (Sediment Exposure)	Sub-Chronic	Not calculated	No	Risk to benthic invertebrates was not assessed because the chlormequat chloride log octanol-water partition coefficient (K_{ow}) and organic carbon normalized soil-water distribution coefficient (K_{oc}) values are below the level used to indicate whether sediment exposure is a primary pathway of concern (K_{oc} is <1000 L/kg$_{oc}$; Log K_{ow} is <3); the soil-water distribution coefficient (K_d) is <50 L/kg.
Mammals	Acute	Dose-based: <0.1-**11**	Yes	Dose-based RQs exceed the acute risk LOC of 0.5 for mammals of all size classes.
	Chronic	Dose-based: 0.4-**62**; Dietary-based: 0.5-**7.2**	Yes	Dose-based RQs exceed the chronic risk LOC of 1 for mammals of all size classes. This is based on 9-24% decreases in body weight and 34% decrease in mean litter size. It should be noted that nurseries are typically highly managed areas in which alternative forage/habitat is intentionally limited. However, exposure to food items cannot be totally ruled out for mammals where residues left on seeds, grasses and arthropods that can serve as food sources for mammals.

Taxa	Exposure Duration	Risk Quotient (RQ) Range[1]	RQ Exceeding the LOC for Non-listed Species	Additional Information/ Lines of Evidence
Birds	Acute	Dose-based: <0.1-**33**; Dietary-based: **<0.2-3.9**	Yes	Dose-based RQs exceed the acute risk LOC of 0.5 for birds of all size classes. The dietary-based RQs are a conservative estimate based on a non-definitive endpoint (>3175 mg/kg-diet).
	Chronic	Dietary-based **2.0-32**	Yes	Dose-based RQs exceed the chronic risk LOC of 1 for birds foraging on all food types except fruit/pods/seeds. This is based on a 5% reduction in the ratio of 14-day hatchlings to number hatched at the LOAEC. It should be noted that nurseries are typically highly managed areas in which alternative forage/habitat is intentionally limited. However, exposure to food items cannot be totally ruled out for birds where residues left on seeds, grasses and arthropods that can serve as food sources for birds.
Terrestrial Invertebrates[3]	Acute (Contact)	Not calculated	No	Toxicity endpoints are non-definitive and higher than the highest dose tested and about 100 times higher than the EEC.
	Acute Larval	Not calculated	No	
	Chronic Adult	**4.1**	Yes	The chronic risk LOC of 1 is exceeded based on a 41% increase in mortality.
	Chronic Larval	**45**	Yes	The chronic risk LOC of 1 is exceeded based on a 15% reduction in adult bee emergence.
Aquatic Plants	N/A	Vascular: 0.7 Non-vascular: <0.01	No	--
Terrestrial Plants	N/A	**2.5**	Yes	RQs exceed the LOC of 1 for risk to monocotyledonous and dicotyledonous terrestrial plants in semi-aquatic areas. This is based on a 6-20% reduction in plant height. Exposure to non-target terrestrial plants in nurseries and shadehouses via spray drift and/or run-off is likely to be limited by the controlled spraying of targeted plants in containers; therefore, these RQs may overestimate risk to terrestrial plants.

LD50=lethal dose for 50% of the organisms tested
Level of Concern (LOC) Definitions:
Terrestrial Vertebrates: Acute=0.5; Chronic=1.0
Terrestrial Invertebrates: Acute=0.4; Chronic=1.0
Aquatic Animals: Acute=0.5; Chronic=1.0
Plants: 1.0

[1] RQs reflect exposure estimates for chlormequat chloride and maximum application rates allowed on labels.

[2] Based on water-column toxicity data compared to pore-water concentration.

[3] RQs for terrestrial invertebrates are applicable to honey bees (Apis mellifera), which serve as surrogate for both *Apis* and non-*Apis* bees. Risks to other terrestrial invertebrates (*e.g.*, earthworms, beneficial arthropods) are only characterized when toxicity data are available.

2 Introduction

This Draft Risk Assessment (DRA) examines the potential ecological risks associated with labeled uses of chlormequat chloride on non-listed non-target organisms. Federally listed threatened/endangered species ("listed") are not evaluated in this document. The DRA uses the best available scientific information on the use, environmental fate and transport, and ecological effects of chlormequat chloride. The general risk assessment methodology is described in the *Overview of the Ecological Risk Assessment Process in the Office of Pesticide Programs* ("Overview Document")(USEPA, 2004a). Additionally, the process is consistent with other guidance produced by the Environmental Fate and Effects Division (EFED) as appropriate. When necessary, risks identified through standard risk assessment methods are further refined using available models and data. This risk assessment incorporates the available exposure and effects data and most current modeling and methodologies.

3 Problem Formulation Update

The purpose of problem formulation is to provide the foundation for the environmental fate and ecological risk assessment being conducted for the labeled uses of chlormequat chloride. The problem formulation identifies the objectives for the risk assessment and provides a plan for analyzing the data and characterizing the risk. As part of the Registration Review (RR) process, a detailed preliminary Problem Formulation (USEPA 2016*a*) for this DRA was published to the docket (EPA-HQ-OPP-2015-0816). The following sections summarize the key points of the preliminary Problem Formulation and discuss key differences between the analysis outlined there and the analysis conducted in this DRA.

As summarized in the preliminary Problem Formulation based on previous risk assessments, the primary risks associated with the use of chlormequat chloride included risks to terrestrial and aquatic plants and terrestrial animals. However, additional studies have been received since the 2016 preliminary Problem Formulation, and some of the environmental fate data previously used have been downgraded and/or not used in aquatic exposure modeling for this assessment. Newly submitted metabolism data were obtained from studies which used exhaustive extraction, unlike previous studies, allowing for the determination that unextracted residues could be considered bound for the purpose of exposure/risk assessment and therefore no longer included as Residues of Concern (ROC) in half-life calculations. Additionally, since the previous risk assessments were completed new modeling scenarios for nurseries have been developed, so turf scenarios are no longer used as surrogates to model exposure from use on ornamentals.

Since the preliminary Problem Formulation was completed, with a preliminary identification of data gaps, EFED reassessed the data that would be needed for risk assessment. A revised list of studies needed for risk assessment was included in EFED's response to public comments

(USEPA 2017*b*) on the Preliminary Work Plan (PWP) for chlormequat chloride. None of the environmental fate data gaps identified in the preliminary Problem Formulation were identified as data gaps in the Final Work Plan (FWP) which was published in June 2017 and is available in the chlormequat chloride Registration Review docket. Additionally, several of the previously identified ecological effects data gaps were removed from the list of needed data. The revised data needs identified in the FWP took into consideration the available data as well as the limited outdoor use patterns for chlormequat chloride.

Since the preliminary Problem Formulation was completed, the following data have been submitted:

- *Fate and Exposure Data*
  - Aerobic aquatic metabolism study (MRID 50747528).
  - Aerobic soil metabolism study (MRID 50747527).
  - Anaerobic aquatic metabolism study (MRID 50747529).

More specific information on these new data is described in Section 5 and 8.1. Summaries of the data are included in **Appendix E**. The additional data result in updated aquatic modeling input values.

- *Ecotoxicity Data*
  - Chronic (early-life stage) toxicity to the freshwater fish Fathead Minnow (*Pimephales promelas*) with chlormequat chloride (TGAI; 66.5% a.i.; MRID 50747506).
  - Chronic (early-life stage) toxicity to the estuarine/marine fish Sheepshead Minnow (*Cyprinodon variegates*) with chlormequat chloride (TGAI; 66.5% a.i.; MRID 51121205).
  - Acute toxicity to Sheepshead Minnow with chlormequat chloride (TGAI; 66.5% a.i.; MRID 50747503).
  - Chronic toxicity to the estuarine/marine invertebrate Mysid (*Americamysis bahia*) with chlormequat chloride (TGAI; 66.5% a.i.; MRID 51121204).
  - Acute toxicity to the estuarine/marine invertebrate Mysid with chlormequat chloride (TGAI; 66.5% a.i.; MRID 50747505).
  - Acute toxicity to the estuarine/marine invertebrate Eastern oyster (*Crassostrea virginica*) with chlormequat chloride (TGAI; 66.5% a.i.; MRID 50747504).
  - Subacute dietary toxicity of chlormequat chloride (TGAI; 66.5% a.i.) to the Zebra finch (*Taeniopygia guttata*; MRID 50747507).
  - Reproductive toxicity of chlormequat chloride (TGAI; 67.8% a.i.) to Mallard duck (*Anas platyrhynchos*; MRID 50747508)
  - Reproductive toxicity of chlormequat chloride (TGAI; 67.8% a.i.) to Northern Bobwhite Quail (*Colinus virginianus*; MRID 50747509).
  - Acute contact and oral toxicity of CCC 750 (TEP, 65.2% a.i.) to adult honey bees (*Apis mellifera spp. mellifera*) (MRID 50747510).
  - Acute oral toxicity of chlormequat chloride (TGAI; 65.5% a.i.) to larval honey bees (MRID 50747513).

- Chronic oral toxicity of chlormequat chloride (TGAI; 65.5% a.i.) to adult honey bees (MRID 50747511).
- Chronic oral toxicity of chlormequat chloride (TGAI; 65.5% a.i.) to larval honey bees (MRID 50747512).
- Seedling emergence test with Manipulator™ (TEP; 56.9%; MRID 50747514).
- Vegetative vigor test with Manipulator™ (TEP; 56.9%; MRID 50747515).

These new data are described in more detail in the effects characterization (**Section 6)**. Summaries of the new data are included in **Appendix F**. Some of these new data provide more sensitive toxicity endpoints than were previously assessed for chlormequat chloride.

3.1 Mode of Action for Target Pests

Chlormequat chloride, [(2-chloroethyl) trimethylammonium chloride salt] is a plant-growth regulator (PGR) and is systemic in plants; the compound was initially registered in 1962 and belongs to the quaternary ammonium class of chemicals. Chlormequat chloride acts through inhibition of the biosynthesis of gibberellic acid, the hormone that promotes plant stem elongation (USEPA, 2016). Plants treated with this product tend to be sturdier and more compact, which may provide greater durability during post-production shipping.

Chlormequat chloride is the salt of a quaternary ammonium cation, a diverse group of molecules commonly known as "quats" which are positively charged molecules (*i.e*., cations) that remain permanently charged in soil or water regardless of the system pH. More specifically, chlormequat chloride has been classified according to the Agency's PR Notice 88-2 (February 26, 1988) as a Group I, alkyl or hydroxyalkyl (straight chain) substituted quaternary ammonium compounds. Another Group I quaternary ammonium salt, didecyldimethylammonium chloride (DDAC) was reregistered by the Antimicrobials Division in 2006 (USEPA D325481, 2006).

3.2 Label and Use Characterization

Chlormequat chloride is registered for use on a variety of ornamentals including herbaceous and woody annual and perennial plants grown in greenhouses, nurseries, and shadehouses. Outdoor use, such as in shadehouses, is restricted to foliar treatment of containerized ornamentals (USEPA 2016*b*). It is not applied to ornamentals planted in the field. Ornamental plants include herbaceous and woody annual and perennial plants such as begonias, vincas, azaleas, and poinsettias. Chlormequat chloride is not registered for use on agricultural crops (*i.e*., those intended for food or animal feed).

There are three technical registrations and three active end-use products registered, which are formulated as soluble concentrates and applied to foliage. Treatment only targets plant foliage, not the soil, as chlormequat must be absorbed into the plant leaves to work; drench applications are not used. Applications are only made at early growth stages and not in later production stages, as exposure to chlormequat in later growth stages (once buds appear) would disrupt bloom. Treatment equipment includes low-pressure handwands, high-pressure handwands, and backpack sprayers. Containerized plants may be treated initially in a greenhouse (with greenhouse spray booms) and then moved to a shadehouse where they receive additional treatments with the previously stated equipment. The Biological and Economic Analysis Division (BEAD) Chemical Profile (BCP; USEPA 2016*b*), located in the docket, lists the use patterns of maximum exposures for the current uses of chlormequat chloride.

3.2.1 Label Summary

BEAD prepared a Master Label Report summarizing all registered uses of chlormequat chloride based on actively registered labels in January 2016 for use in Registration Review. The report was used as the source of information for **Table 3-1**. BEAD also prepared a memo on the foliar application rates for use in assessing aquatic exposure from the use of chlormequat chloride on shadehouse-grown ornamentals (USEPA 2017*a*). The 2017 memo also included the maximum per-acre equivalent application rates for foliar spot treatments (based on three different spray concentrations) for use in assessing terrestrial exposure. The application rates reported in the BEAD 2017 memo are based on the Cycocel® label (EPA Reg No. 241-74). Additionally, the technical registrant responded to some clarifying questions on labels and the responses are considered in the use summary.

Based on the BEAD 2017 memo, "*For foliar spray applications in shadehouses/nurseries, the maximum label rate is 3.7 (lbs.) active ingredient (a.i.) per acre for a single application*" for aquatic exposure. BEAD also stated in the memo that the application rate for assessing terrestrial exposure is 8.24 lbs. a.i./A. and that "*Though this spot treatment rate is higher than the maximum label rate on a per acre basis, spot treatments only cover a very small area and applications for this purpose would not exceed the maximum per acre label rate*."

Based on the Cycocel® label, the maximum single application rate is 3.7 lbs. a.i./A with an annual maximum rate of 33 lbs./A/yr. The label restricts the number of applications to a maximum of three per production cycle and limits the number of growing cycles to a maximum of three per year.

Table 3-1. Summary of the Maximum Labeled Use Patterns for Chlormequat Chloride.

Use Site/ Location	Form	App Target	App Type	App Equip	App Timing	Max Single Rate lbs ai/A	Max # App/yr*	Max Annual Rate lbs ai/A/yr*	MRI (d)	PHI (d)	Comments (*e.g.,* geographic/application timing restrictions, pollinator specific language)	Drift Restrictions
Ornamentals/ Nursery	SC/L	Foliage/ Plant	Spray	G[1]	Potted plants[2]	3.7	3/CC 3 CC/yr	33.3	5	–	Plants may be treated 3X with minimum 5-day intervals for each production cycle (*i.e.*, set of potted plants).	–

App=application; equip=equipment; Form=formulation; --=not specified; SC=soluble concentrate; L=liquid; MRI = Minimum retreatment interval; PHI=preharvest interval; G=ground; ai=active ingredient; CC=crop cycle; d=day;

* Information is provided on an annual basis, unless otherwise specified.

[1]Spray equipment used outdoors is handheld or backpack sprayers.

[2] Plants may be treated initially indoors using greenhouse sprayers prior to being moved outdoors to shadehouses.

3.2.2 Usage Summary

The BCP (USEPA, 2016) includes limited information on the usage of chlormequat chloride, including some information on average application rates. However, the BCP indicates that the reported average rate data may not reflect actual usage of chlormequat chloride across the entire nursery and floriculture market. As reported in the BCP, based on non-agricultural data from 2009 and 2011, usage of chlormequat chloride averaged 1,350 lbs/yr in the nursery and floriculture market (USEPA, 2016).

As stated in BEAD's 2017 memo, *"California is the top producer of floriculture crops, with 25% of U.S. production (USDA 2016). In 2014, California Department of Pesticide Regulation (Cal DPR) reported that the largest outdoor nursery area treated with chlormequat chloride was eight acres. Based on Cal DPR Pesticide Use Reporting System the actual application rate of chlormequat chloride is much less than label rates (average rate of 1.57 lbs. a.i. per acre for 2014), and the maximum application rate was reported as 3.67 lbs. a.i./acre."*

4 Residues of Concern

In this risk assessment, the stressors are those chemicals that may exert adverse effects on non-target organisms. Collectively, the stressors of concern are known as the Residues of Concern (ROC). The ROC usually includes the active ingredient, or parent chemical, and may include one or more transformation products that are observed in laboratory or field environmental fate studies. Degradates may be included in, or excluded from, the ROC based on submitted toxicity data, percent formation relative to the application rate of the parent compound, modeled exposure, and structure-activity relationships (SARs). Structure-activity analysis may be qualitative, based on retention of functional groups in the degradate, or they may be quantitative, using programs such as ECOSAR, the OECD Toolbox, ASTER, or others.

The ROC for this assessment is comprised of only the parent compound based on exposure potential. The only major transformation products identified in the environmental fate studies were carbon dioxide (CO_2) and bound residues. Because extraction was considered exhaustive for the new metabolism studies, and based on current guidance, unextracted residues are no longer included as ROC as they were in past assessments for chlormequat chloride. While there were unidentified minor degradates detected in the aquatic metabolism studies, they were detected only sporadically and at <1% of the applied in the aquatic metabolism studies.

5 Environmental Fate Summary

Table 5-1 summarizes the physical chemical properties of chlormequat chloride. Chlormequat chloride is classified as non-volatile from water and dry non-adsorbing surfaces (USEPA, 2010a). Chlormequat chloride is highly soluble in water and is expected to be somewhat mobile in some soils based on measured soil-water distribution coefficient (K_d) values, despite its existence as a cation in the environment which would be expected to sorb to soils because of its positive charge. In new laboratory aquatic metabolism studies, the compound was still present in the water at 32.1-49.1% of the applied in a flooded sand sediment while present in the water at 1.02-22.6% of the applied in a flooded loam sediment at study termination (100-102 days). It does, however, also form bound residues in soils and sediments, with up to 14.9% of the applied forming bound residues in the new aerobic soil metabolism study and up to 42.9% as bound residues in the two aquatic metabolism studies. Additionally, extractable residues in the sediment phase of the aquatic metabolism systems were present at levels similar to or greater than the levels of bound residues. Thus, depending on soil, site and meteorological conditions in the environment, chlormequat chloride may be transported off-site via runoff, leaching and/or erosion. While it may be found in both water and sediment, the octanol-water partition coefficient (K_{ow}) and organic-carbon normalized soil-water distribution coefficient (K_{oc}) values are much lower than the values that would trigger the need to conduct a separate sediment exposure assessment (40 CFR Part 158.630).[1]

Although empirical bioconcentration data have not been submitted, chlormequat chloride is not expected to bioconcentrate in fish or bioaccumulate in aquatic ecosystems. The reported octanol-water partitioning coefficient is relatively low (log K_{ow} = <2.51. Compounds with a log K_{ow} of three and above are generally considered to have the potential to bioconcentrate in aquatic organisms. Based on the reported log K_{ow}, bioconcentration of the chemical is not a primary concern.

Table 5-1. Summary of Physical-Chemical, Sorption, and Bioconcentration Properties of Chlormequat Chloride.

Parameter	Value[1]	Source/Study Classification/Comment
Molecular Weight (g/mole)	158.1	--
Water Solubility Limit at 20°C (mg/L)	1 x 10^6 mg/L	MRID 46686204 Acceptable
Vapor Pressure at 20°C (Torr)	7.5 x 10^{-8}	USEPA 2007; DP336709
Henry's Law Constant at 20°C (atm-m³/mole)	4.8 x 10^{-14}	Estimated[1] from vapor pressure and water solubility at 20°C.
Log Dissociation Constant (pKa)	No dissociation between pH 2 -10	MRID 46686204 Acceptable
Octanol-Water Partition Coefficient (log K_{ow}) at 20°C (unitless)	<2.51	MRID 46686204 Acceptable

[1] Sediment data may be required if the soil-water distribution coefficient (K_d) is ≥ 50 L/kg, K_{oc}s are ≥1000 L/kg-organic carbon, or the log K_{ow} is ≥ 3 (40 CFR Part 158.630). Sediment data may also be requested if there may be a toxicity concern.

Parameter	Value[1]			Source/Study Classification/Comment
Air-Water Partition Coefficient (K_{AW}) (unitless)	log K_{AW} = -12.2			EPIWeb Version 4.1
Soil-Water Distribution Coefficients (K_d in L/kg-soil or sediment at 10°C) Organic Carbon-Normalized Distribution Coefficients (K_{oc} in L/kg-organic carbon at 10°C)	**Soil/Sediment**	**K_d**	**K_{OC}**	MRIDs 46715228, 46715229. Acceptable. The mobility classification was not determined because K_{oc} is not used to predict mobility of ionic compounds. Study was conducted at 10°C, possibly increasing adsorption relative to guideline studies conducted at 20°C.
	Loamy sand	1.3	55	
	Sandy loam	4.6	291	
	Silt loam	1.1	81	
	Sand	1.7	93	
	Sandy loam	2.1	89	
	Loam	9.1	912	
	Silt loam	8.1	385	
Fish Bioconcentration Factor (BCF) (L/kg-wet weight fish or L/kg wet weight lipid)	**Species**	**BCF**	**Depuration**	No data submitted. Data not requested for Registration Review. (USEPA 2017*b*; DP437685)
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[1]All estimated values were calculated according to "*Guidance for Reporting on the Environmental Fate and Transport of the Stressors of Concern in Problem Formulations for Registration Review, Registration Review Risk Assessments, Listed Species Litigation Assessments, New Chemical Risk Assessments, and Other Relevant Risk Assessments*" (USEPA, 2010a).

Chlormequat chloride is degraded by aerobic metabolism in soils (half-lives ranged from 192 to 283 days in four US soils at 20°C in a new study but were 30-43 days in foreign soils that were not subjected to exhaustive extractions in a previously submitted study in which data validity and material balance issues were also identified). New aerobic soil metabolism results from the US soils indicate that chlormequat chloride is persistent in soil based on the Goring persistence scale (Goring *et al*., 1975).[2] Because the new study utilized exhaustive extractions with extractants spanning a range of dielectric constants, residues remaining in the four soils following extraction (maximums of 9.7-14.9%) are considered bound residues and not likely to contribute to the exposure of aquatic taxa to ROCs. In previous assessments, the unextracted residues in the aerobic soil metabolism study were considered ROC and factored into half-lives using a Total Residues (TR) approach that is not used in this current assessment.

Chlormequat chloride is stable to hydrolysis (pH 5, 7, and 9) and to photolysis in water. The compound ranges from persistent to essentially stable to anaerobic aquatic metabolism, with substantially different half-lives (471 vs. 3.7×10^4 days) in the two systems studied. In both of the anaerobic aquatic systems studied, however, the only major transformation products were carbon dioxide and bound residues, as was also the case for both the aerobic soil and aerobic

[2] *Goring et al. (1975) provides the following persistence scale for aerobic soil metabolism half-lives:*

- *Non-persistent less than 15 days*
- *Slightly persistent for 15-45 days*
- *Moderately persistent for 45-180 days, and*
- *Persistent for greater than 180 days.*

aquatic metabolism studies. In the previously submitted aerobic aquatic metabolism study (MRID 46715227), chlormequat chloride was not persistent in a river water-sandy loam sediment and a pond water-silt loam sediment system. However, that study has recently been downgraded to a classification of “not acceptable” due to multiple data validity issues. In a new submitted aerobic aquatic metabolism study, chlormequat chloride was relatively more persistent than in the previous study and was much more persistent in one of the two systems studied, with half-lives of 68 days and 445 days. As noted previously for the new aerobic soil study, the new aerobic aquatic metabolism study utilized exhaustive extractions and the unextracted residues remaining in the sediment (20.3-38.3%) are considered bound residues for the purposes of risk assessment.

Table 5-2 summarizes representative degradation half-life values from laboratory degradation data for chlormequat chloride. These values often are different from the actual time to 50 percent decline of the residues as degradation kinetics were often biphasic with the rate of degradation slowing over time. The representative degradation half-life is designed to provide an estimate of degradation for biphasic degradation curves that will not overestimate degradation when assuming a single first-order decline curve in modeling.

There were no major transformation products of chlormequat chloride identified in submitted environmental fate studies other than carbon dioxide (CO_2) and bound residues. Unidentified minor degradates were detected only sporadically and at <1% of the applied in the aquatic metabolism studies.

There are no terrestrial field dissipation data available for the single currently registered use of chlormequat chloride on ornamentals in greenhouses and shadehouses.

Table 5-2. Summary of Environmental Degradation Data for Chlormequat Chloride.

Study	System Details	Representative Half-life (days)[1,2]	Source/Study Classification/Comment
Abiotic Hydrolysis	50°C; pH 4,7,9	Stable	MRID 47769403 Acceptable
Atmospheric Degradation	Hydroxyl Radical	1.5	Estimated value EPIWeb Version 4.1
Aqueous Photolysis	20°C; pH 5.4 40°N	Stable	MRID 47769404 Acceptable
Soil Photolysis	No data	–	Data not requested for Registration Review. (USEPA 2017*b*; DP 437685)
Aerobic Soil Metabolism	ND Loam, pH 6.6, 20°C	192 (IORE)	MRID 50747527[N] Acceptable
	ND Loamy Sand, pH 5.5, 20°C	283 (SFO)	
	ND Sand, pH 7.8, 20°C	247 (SFO)	
	CA Loam, pH 6.9, 20°C	243 (SFO)	

Study	System Details	Representative Half-life (days)[1,2]	Source/Study Classification/Comment
	German Loamy sand, pH 5.8, 20°C	43.4 (SFO)	MRID 46715225 Supplemental; material balance and data variability issues, soil extraction issues, and no domestic soils. All foreign soils with a different degradation profile *vs.* domestic soils.
	Swiss Loamy sand, pH 7.7, 20°C	29.7 (SFO)	
	Swiss Silt loam, pH 7.5, 20°C	31.5 (SFO)	
	Swiss Silt loam, pH 7.4, 20°C	43.0 (SFO)	
Aerobic Aquatic Metabolism	Taunton River, MA loam sediment, 20°C	67.9 (DFOP, Slow)	MRID 50747528[N] Acceptable
	Weweantic River, MA sand sediment, 20°C	445 (DFOP, Slow)	
Anaerobic Aquatic Metabolism	Taunton River, MA loam sediment, 20°C	471 (IORE)	MRID 50747529[N] Acceptable
	Weweantic River, MA sand sediment, 20°C	3.71×10^4 (IORE)	

SFO=single first order; DFOP=double first order in parallel; IORE=indeterminate order (IORE); SFO DT_{50}=single first order half-life; T_{IORE}=the half-life of a SFO model that passes through a hypothetical DT_{90} of the IORE fit; DFOP slow DT_{50}=slow rate half-life of the DFOP fit, --=not available or applicable; SFO-LN=SFO calculated using natural log transformed data

[N] Studies submitted since the Problem Formulation was completed are designated with an N associated with the MRID number.

[1] The value used to estimate a model input value is the calculated SFO DT_{50}, T_{IORE}, or the DFOP slow DT_{50} from the DFOP equation. The model chosen is consistent with that recommended using the, *Guidance for Evaluating and Calculating Degradation Kinetics in Environmental Media* (NAFTA, 2012).

6 Ecotoxicity Summary

Ecological effects data are used to estimate the toxicity of chlormequat chloride to non-target organisms through the use of surrogate species. The ecotoxicity data for chlormequat chloride have been reviewed in a previous Ecological Risk Assessment (ERA; USEPA, 2006, DP Barcode D333104).

Various studies with terrestrial and aquatic plants, aquatic animals, birds and terrestrial invertebrates exposed to either the technical grade active ingredient (TGAI) or typical end-use (formulated) product (TEP) have been received since the preliminary Problem Formulation was issued in 2016 (USEPA, 2016); the results of these studies are described briefly in this section with additional details presented in the previous risk assessment (USEPA 2006).

New aquatic toxicity studies submitted include chronic toxicity tests with the freshwater Fathead Minnow (*Pimephales promelas*), and acute toxicity tests with the estuarine/marine (E/M) Sheepshead Minnow (*Cyprinodon variegatus*), E/M Eastern Oyster (*Crassostrea virginica*) and E/M invertebrate Mysid Shrimp (*Americamysis bahia*). Newly submitted terrestrial toxicity studies include chronic tests with Northern Bobwhite Quail (*Colinus virginianus*), Mallard Duck (*Anas platyrhynchos*) and an acute oral test with Zebra Finch (*Taeniopygia guttata*). New acute and chronic terrestrial invertebrate toxicity tests for both adult and larval honey bees have been submitted. A new seedling emergence and a vegetative vigor tests with the TEP (Manipulator™) have also been submitted. Some of these new data provide more sensitive toxicity endpoints than were previously assessed for chlormequat chloride.

Tables 6-1 and **6.2** summarize the ecological toxicity data submitted for assessing potential risk to non-target organisms from the registered use of chlormequat chloride. **Tables 6-1** and **6-2** represent data for aquatic and terrestrial taxa, respectively. All studies in these tables are classified as acceptable or supplemental. Non-definitive endpoints are designated with a greater than (>) or less than (<) value. Values that are based on newly submitted data are designated with a superscript N.

A search of the public ECOTOXicology Knowledgebase (https://cfpub.epa.gov/ecotox/index.cfm) in October 2020 yielded no additional data with more sensitive toxicity values than those used from the studies submitted to support the registration of chlormequat chloride.

6.1 Aquatic Toxicity

Aquatic vertebrates

Chlormequat chloride is classified as practically non-toxic to the freshwater Rainbow Trout (*Oncorhynchus mykiss*; LC_{50} >1,000,000 µg ai/L; MRID 123261) and E/M fish Sheepshead Minnow (LC_{50} >100,000 µg ai/L; MRID 50747503) on an acute exposure basis. Since freshwater fish serve as surrogates for aquatic-phase amphibians, chlormequat chloride is classified as practically non-toxic on an acute exposure basis to aquatic-phase amphibians as well. Chronic exposure of chlormequat chloride to Rainbow Trout in an early life stage (ELS) toxicity test resulted in no detectable lethal or sublethal effects up to the highest concentration tested (NOAEC = 102,000 µg ai/L; LOAEC >102,000 µg ai/L; MRID 47769401). Two newly submitted ELS toxicity studies also indicate that chronic exposure of chlormequat chloride has no significant effect on freshwater Fathead Minnow (*Pimephales promelas*; NOAEC = 10,000 µg ai/L; LOAEC >10,000 µg ai/L; MRID 50747506) and estuarine/marine Sheepshead Minnow up to the highest tested concentration (NOAEC = 9,150 µg ai/L; LOAEC >9,150 µg ai/L; MRID 51121205).

Aquatic invertebrates

Chlormequat chloride is slightly toxic to both the freshwater invertebrate waterflea (*Daphnia magna*; IC_{50} = 16,900 µg ai/L; MRID 40094602) and the E/M invertebrate Eastern oyster

(*Crassostrea virginica*; IC_{50} = 50,000 µg ai/L; MRID 50747504), but practically non-toxic to the E/M Mysid Shrimp (LC_{50} = 110,000 µg ai/L; MRID 50747505) on an acute exposure basis. Chronic exposure of daphnids to chlormequat chloride resulted in a NOAEC of 5,000 µg ai/L based on a 20% reduction in live offspring at the LOAEC of 10,000 µg ai/L (MRID 46715216); however, the compound had no detectable lethal or sublethal effect on the E/M Mysid Shrimp up to the highest tested concentration (NOAEC = 9,260 µg ai/L; LOAEC >9,260 µg ai/L; MRID 51121204).

Aquatic plants and algae

A 72-h exposure of the non-vascular freshwater cyanobacterium, *Anabaena flos-aquae* to chlormequat chloride TGAI resulted in NOAEC and EC_{50} values of 207,000 and >207,000 µg ai/L, respectively (MRID 46715223). A 7-day toxicity study with the vascular aquatic plant duckweed (*Lemna gibba*) resulted in NOAEC and EC_{50} values of 40 and 2,600 µg ai/L, respectively based on a 16% reduction in frond number at the LOAEC of 320 µg ai/L (MRID 46715221). A 72-h exposure of the non-vascular freshwater green algae *Scenedesmus subspicatus* to chlormequat chloride TEP STABILAN™ (465 g ai/L) resulted in NOAEC and EC_{50} values of 233,000 and >899,000 µg ai/L, respectively based on a 12% reduction in biomass at the LOAEC of 899,000 µg ai/L (MRID 46715222).

Table 6-1. Aquatic Toxicity Endpoints Selected for Risk Estimation for Chlormequat Chloride.

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in µg a.i./L (unless otherwise specified)[1]	MRID or ECOTOX No./ Classification	Comments
Freshwater Fish (Surrogates for Vertebrates)[2]					
Acute	TGAI	Rainbow Trout (*Oncorhynchus mykiss*)	**LC_{50} > 1,000,000**	123261 Acceptable	Practically non-toxic
Sub-acute (OECD 204)	TGAI (63.3%)	Rainbow trout (*Oncorhynchus mykiss*)	LC_{50} > 1,400,000 NOAEC = 1,400,000	46715217 Supplemental	Study is classified supplemental because it is a non-guideline 21-day sub-acute toxicity study.
Chronic (Early-life stage)	TGAI (96.6%)	Rainbow trout (*Oncorhynchus mykiss*)	NOAEC= 102,000 LOAEC >102,000	47769401 Supplemental	No effect up to the highest tested concentration. Study is classified supplemental because it was initiated with juvenile fish rather than with embryos.
	TGAI (66.5%)	Fathead minnow (*Pimephales promelas*)	**NOAEC = 10,000** LOAEC > 10,000	50747506[N] Acceptable	No effect up to the highest tested concentration.
Estuarine/Marine Fish (Surrogates for Vertebrates)					
Acute	TGAI (66.5%)	Sheepshead Minnow (*Cyprinodon variegates*)	**LC_{50} > 100,000**	50747503[N] Acceptable	Practically non-toxic
Chronic (Early-life stage)	TGAI (66.5%)		**NOAEC > 9,150** LOAEC > 9,150	51121205[N] Acceptable	No effect up to the highest tested concentration.

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value in µg a.i./L (unless otherwise specified)[1]	MRID or ECOTOX No./ Classification	Comments
Freshwater Invertebrates (Water-Column Exposure)					
Acute	TGAI (95.6%)	Waterflea (*Daphnia magna*)	**96-h EC_{50} = 16,900**	00138719 Supplemental	Slightly toxic
Chronic			**NOAEC = 5000** LOAEC = 10,000	46715216 Supplemental	20% reduction in live offspring at the LOAEC. Study was classified supplemental because a growth endpoint was not assessed.
Estuarine/Marine Invertebrates (Water-Column Exposure)					
Acute	TGAI (66.5%)	Mysid (*Americamysis bahia*)	LC_{50} > 110,000	50747505[N] Acceptable	Practically non-toxic
Acute	TGAI (66.5%)	Eastern oyster shell deposition (*Crassostrea virginica*)	**IC_{50} = 50,000**	50747504[N] Acceptable	Slightly toxic.
Chronic	TGAI (66.5%)	Mysid (*Americamysis bahia*)	**NOAEC = 9,260** LOAEC > 9,260	51121204[N] Acceptable	No effect up to the highest tested concentration.
Aquatic Plants and Algae					
Vascular	TGAI 753 g/L	Duckweed (*Lemna gibba*)	**EC_{50} = 2,600** NOAEC = 40	46715221 Acceptable	Based on a 16% reduction in frond number.
Non-vascular	TGAI 753 g/L	Freshwater cyanobacteria (*Anabaena flos-aquae*)	**EC_{50} > 207,000** NOAEC = 207,000	46715223 Supplemental	This study was classified as supplemental because it was conducted for only 72 hours.
	TEP STABILAN™ 465 g/L	Freshwater green algae (*Scenedesmus subspicatus*)	EC_{50} > 899,000 NOAEC = 233,000	46715222 Acceptable	--

Bolded values used for risk quotient (RQ) calculation.

[1]No-observed adverse effect concentration (NOAEC) and lowest observed adverse effect concentration (LOAEC) are reported in the same units.

[2]Freshwater fish are used as surrogates for aquatic-phase amphibians.

TGAI=Technical Grade Active Ingredient; TEP= Typical end-use product; a.i.=active ingredient

>Greater than values designate non-definitive endpoints where no effects were observed at the highest level tested, or effects did not reach 50% at the highest concentration tested (USEPA, 2011).

< Less than values designate non-definitive endpoints where growth, reproductive, and/or mortality effects are observed at the lowest tested concentration.

[N] Denotes studies submitted since the preliminary Problem Formulation was completed; designated with an N associated with the Master Record Identification (MRID) number.

6.2 Terrestrial Toxicity

Terrestrial vertebrates

Chlormequat chloride TGAI is slightly toxic to Japanese Quail (*Coturnix japonica*; LD_{50}=556 mg ai/kg bw; MRID 46715210) on an acute oral exposure basis. The compound is at most slightly toxic to Japanese Quail (LC_{50}>3,175 mg ai/kg diet; MRID 46715212) and practically non-toxic to Mallard Ducks (LC_{50}>5,438 mg ai/kg diet; MRID 46715213) and to Zebra Finch (LC_{50}>6,979 mg ai/kg diet; MRID 50747507) on a subacute dietary exposure basis. Since birds serve as surrogates for reptiles and terrestrial-phase amphibians, the toxicity classifications for birds apply to these taxa as well.

A supplemental avian reproduction study with the Japanese Quail was submitted in which the most sensitive endpoint was a 7% reduction in adult food consumption at all treatment levels (NOAEC <158 mg ai/kg diet; MRID 46715214). In a newly submitted reproduction study with Northern Bobwhite Quail, the only significant effect was a 5% reduction in the ratio of number of 14-day survivors to eggs hatched (NOAEC = 390; LOAEC = 658 mg/kg diet; MRID 50747509). This endpoint was significantly reduced ($p<0.05$) in the highest dietary treatment concentration; however, both the mean and median measures of central tendency from this treatment group were heavily influenced by a single replicate with a lower value. In another avian reproduction study, exposure of Mallard Ducks to chlormequat chloride did not result in any detectable adverse effects up to the highest dietary concentrations tested (NOAEC = 793; LOAEC > 793 mg/kg diet; MRID 50747508).

Chlormequat chloride is moderately toxic to rats (*Rattus norvegicus*) on an acute oral exposure basis (LD_{50}=487 mg ai/kg bw; MRID 41721604). In a two-generation study with rats (*R. norvegicus*), chlormequat chloride exposure resulted in a 5-10% decrease in body weight of the parental females, 9-24% decrease in body weight of their offspring, and 34% decrease in mean litter size (NOAEL = 86.4 mg ai/kg bw; LOAEL = 255 mg ai/kg bw; MRID 46715206).

Terrestrial invertebrates

Chlormequat chloride TGAI is practically non-toxic to adult honey bees on both, acute contact (LD_{50} >100 µg ai/bee) and oral (LD_{50}>100 µg ai/bee) exposure basis (MRID 46715224). Exposure to TEP CCC 750 (65.2% a.i.) is also practically non-toxic to adult honey bees on acute oral (LD_{50} >80 µg ai/bee) and contact exposure basis (LD_{50} >65 µg ai/bee) (MRID 50747510). Since honey bees serve as surrogates for both *Apis* and non-*Apis* bees, the acute toxicity classifications apply to these species of bees as well. Chlormequat chloride is practically non-toxic to honey bee larvae (LD_{50}>91.2 µg ai/larva; MRID 50747513) on an acute exposure basis. Chronic exposure of larvae resulted in a 15% reduction in adult bee emergence (NOAEL 2.5 µg ai/larva/day; MRID 50747512) while chronic exposure of adult bees resulted in a 41% increase in mortality (NOAEL=64 µg ai/bee/day; MRID 50747511).

Terrestrial and wetland plants

In a non-guideline seedling emergence test with the chlormequat chloride TEP CCC 720 Feinchemie (65.2% a.i.), oilseed rape, *Brassica napus* was the most sensitive dicotyledonous plant (dicot; 0.9> IC_{25} >1.9 lbs ai/A; NOAEC = 0.9346 lbs ai/A) based on a 38% reduction in percent emergence (MRID 46715219). There were no effects detected up to the highest application rate tested for any of the monocotyledonous (monocot) species. This study is classified as supplemental because it deviated considerably from the guidelines for a Tier II seedling emergence study. For example, only six plant (4 dicots, and 2 monocots) were tested, instead of the preferred 10 species specified in the guideline. In response to these deficiencies, a new seedling emergence study with chlormequat chloride TEP (Manipulator™; 57% active ingredient) tested on 11 species (4 monocots and 7 dicots; MRID 50747514) was submitted. The most sensitive monocot was oat, based on a 12% reduction in plant height, with NOAEC and IC_{25} values of 1.2 and >2.6 lbs ai/A, respectively. The most sensitive dicot was sugar beet, based on a 20% reduction in plant height, with NOAEC and IC_{25} values of 0.68 and 1.7 lbs ai/A, respectively (MRID 50747514).

A non-guideline vegetative vigor test with the TEP BAS 062 03 W (63.3% a.i.) was submitted, with only six plants (4 dicots, 2 monocots) tested, rather than the 10 species preferred in guideline studies. The most sensitive dicot species was sunflower, *Helianthus annuus* with an EC_{25} of 1.5 lb ai/A (MRID 46715220). A NOAEC was not determined due to significant ($p<0.05$) reductions in fresh weight (biomass) at all treatment concentrations (>25% at the lowest treatment). No monocot species was significantly affected at any treatment level (IC_{25} >3.4 lbs ai/A; NOAEC = 3.4 lbs ai/A). Data with TEP BAS 062 03 W tested on sunflower at concentrations of ≤0.21 lbs a.i./A will have to be submitted to completely assess the effect of the TEP on terrestrial plants. A new vegetative vigor study was submitted with TEP Manipulator™ (56.9% ai). The most sensitive monocot was oat, based on a 6% reduction in plant height, with NOAEC and IC_{25} values of 0.38 and >3.0 lbs ai/A, respectively (MRID 50747515). The most sensitive dicot species was oilseed rape, based on a 19% reduction in plant height, with NOAEC and IC_{25} values of 1.5 and >3.0 lbs ai/A, respectively.

Table 6-2. Terrestrial Toxicity Endpoints Selected for Risk Estimation for Chlormequat Chloride.

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value[1]	MRID or ECOTOX No./ Classification	Comments
Birds (Surrogates for Terrestrial Amphibians and Reptiles)[2]					
Acute oral	TEP (465 g ai/L)	Japanese quail (*Coturnix japonica*)	**LD_{50} = 556 mg a.i./kg bw**	46715210 Supplemental	This study was conducted with Japanese quail.
Sub-acute dietary	TGAI (66.5)	Zebra finch (*Taeniopygia guttata*)	8-day LC_{50} >6,978 mg a.i./kg diet	50747507[N] Acceptable	Practically non-toxic.
	TGAI (63.5%)	Japanese quail (*Coturnix japonica*)	**8-day LC_{50} >3,175 mg a.i. /kg diet**	46715212 Supplemental	Practically non-toxic.
	TGAI (66.9%)	Mallard duck (*Anas platyrhynchos*)	LC_{50} > 5,438 mg a.i./kg diet	46715213 Acceptable	Practically non-toxic.
Chronic	TGAI (66.9%)	Japanese Quail (Coturnix japonica)	NOAEC < 158 mg a.i./kg diet	46715214 Supplemental	Significant reductions in food consumption and male body weight gain at all treatment levels.
	TGAI (67.8%)	Northern Bobwhite Quail (*Colinus virginianus*)	**NOAEC = 390 mg/ kg diet**; LOAEC = 658 mg/kg diet NOAEL = 45.5 mg/kg-bw; LOAEL = 74.7 mg/kg-bw	50747509[N]	Based on a 5% reduction in the ratio of 14-day hatchlings to number hatched at the LOAEC.
	TGAI (67.8%)	Mallard Duck (*A. platyrhynchos*)	NOAEC = 793 mg/ kg diet; LOAEC > 798 mg/kg diet NOAEL = 68.3 mg/kg-bw; LOAEL > 68.3 mg/kg-bw	50747508[N]	No statistically significant effect detected up to the highest treatment concentration/dose tested.
Mammals					
Acute Oral	TGAI 66.1%		**LD_{50} = 487 mg/kg-bw**	41721604 Acceptable	Moderately toxic

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value[1]	MRID or ECOTOX No./ Classification	Comments
Chronic (2-generation reproduction)	TGAI 67.4%	Norway rat (*Rattus norvegicus*)	**NOAEL = 86.4 mg/kg-bw** LOAEL = 255 mg/kg-bw Estimated NOAEC = 1,728 mg ai/kg diet	46715206 Acceptable	Based on a 5-10% decrease in body weight of female of the Parental (P) generation, 9-24% decrease in body weight of first generation (F_1) parents, and 34% decrease in mean litter size.
Terrestrial Invertebrates					
Acute contact	TGAI (%)	Honey bee (*Apis mellifera L.*)	**LD_{50} >100 µg a.i./bee**	46715224 Acceptable	Practically non-toxic
	TEP (CCC 750; 65.2%)	Honey bee (*Apis mellifera L.*)	LD_{50} >65 µg a.i./bee	50747510[N]	Practically non-toxic
Acute oral (Adult)	TGAI	Honey bee (*Apis mellifera L.*)	**LD_{50} > 100 µg a.i./bee**	46715224 Acceptable	Practically non-toxic
	TEP (CCC 750; 65.2%)	Honey bee (*Apis mellifera L.*)	LD_{50} > 80 µg a.i./bee	50747510[N]	Practically non-toxic
Chronic (adult)	TGAI (66.5%)	Honey bee (*Apis mellifera L.*)	**NOAEL = 64 µg a.i./bee/d** LOAEL = 139 µg a.i./bee/d	50747511[N]	Based on a 41% increase in mortality.
Acute oral (larvae)	TGAI (66.5%)	Honey bee (*Apis mellifera L.*)	**LD_{50} > 91.2 µg a.i./larva**	50747513[N]	Practically non-toxic.
Chronic (larvae)	TGAI (66.5%)	Honey bee (*Apis mellifera L.*)	ED_{50}>25 µg ai/larva/day **NOAEL = 2.5 µg a.i./larva/day** LOAEL =8.3 µg a.i./larva/day	50747512[N]	Based on a 15% reduction in adult emergence at the LOAEL.

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value[1]	MRID or ECOTOX No./ Classification	Comments
Terrestrial and Wetland Plants					
Seedling Emergence	TEP (CCC 720 Feinchemie) 708 g/L	Various species	Dicots (oilseed rape, *Brassica napus*): IC_{25} 0.9346-1.8692; NOAEC = 0.9 lbs a.i./A Monocots (no effects): IC_{25} >1.9; NOAEC = 1.9 lbs a.i./A	46715219 Supplemental	38% reduction in percent emergence of oilseed rape; no effects on any monocot tested. Only 6 species (4 dicots and 2 monocots) were used instead of the recommended 10.
	(TEP) (Manipulator ™; (56.9%)	Various species	Dicots (sugarbeet, *Beta vulgaris*): **IC_{25} = 1.7**; NOAEC = 0.68 lbs a.i./A Monocots (oat, *Avena sativa*): **IC_{25} >2.6**; NOAEC = 1.2 lbs a.i./A	50747514[N]	Based on a 20 and 12% reduction in plant heights in dicot and monocot plants, respectively.
Vegetative Vigor	TEP (BAS 062 03 W) 63.3% ai	Various species	Dicots (sunflower, *Helianthus annuus*): IC_{25} = 1.5; NOAEC <0.21 lbs a.i./A Monocots (no effects): IC_{25} >3.4; NOAEC = 3.4 lbs a.i./A	46715220 Supplemental	Based on a 5% reduction in fresh weight at the lowest treatment concentration for sunflower. There were significant effects at all treatment concentrations for sunflower. Study was classified as supplemental because test concentrations were not low enough to cover all potential exposures. Data with sunflower tested at ≤0.21 lbs a.i./A is needed to completely assess the effect of the TEP on terrestrial plants.

Study Type	Test Substance (% a.i.)	Test Species	Toxicity Value[1]	MRID or ECOTOX No./ Classification	Comments
	(TEP) (Manipulator ™; 56.9%)	Various species	Dicots (oilseed rape, *Brassica napus*): **IC_{25} > 3.0;** NOAEC = 1.5 lbs a.i./A Monocots (oat, *Avena sativa*): **IC_{25} >3.0;** NOAEC = 0.38 lbs a.i./A	50747515[N]	Based on a 19 and 6% reduction in plant heights in dicot and monocot plants, respectively.

Bolded values used to generate risk quotient (RQ).
TGAI=Technical Grade Active Ingredient; TEP= Typical end-use product; a.i.=active ingredient
[N] Denotes studies submitted since the preliminary Problem Formulation was completed; designated with an N associated with the Master Record Identification (MRID) number.
[1] No-observed adverse effect concentration (NOAEC) and lowest observed adverse effect concentration (LOAEC) are reported in the same units.
[2] Birds are used as surrogates for reptiles and terrestrial-phase amphibians.
>Greater than values designate non-definitive endpoints where no effects were observed at the highest level tested, or effects did not reach 50% at the highest concentration tested (USEPA, 2011).
< Less than values designate non-definitive endpoints where growth, reproductive, and/or mortality effects are observed at the lowest tested concentration.

6.3 Incident Data

The Incident Data System (IDS) provides information on the available ecological pesticide incidents, including those that have been aggregately reported to the EPA since chlormequat chloride was first registered in 2007 to when the database was searched on February 2021. As of February 2021, there are no ecological incidents on chlormequat chloride reported in the IDS. Also, from the period September 2007 to present, there are no aggregate incidents reported. Although no incidents are reported in the IDS, the absence of such reports cannot be construed as the absence of incidents since there can be multiple factors that limit the extent to which incidents may be reported to the Agency. For example, EPA's changes in the registrant reporting requirements for incidents in 1998 may account for a reduced number of non-aggregated reported incidents. Registrants are now only required to submit detailed information on "major" fish, wildlife, and plant incidents. Minor fish, wildlife, and plant incidents, as well as all other non-target incidents, are generally reported aggregately.

7 Analysis Plan

7.1 Overall Process

This assessment uses a weight-of-evidence approach that relies heavily, but not exclusively, on a risk quotient (RQ) method. The RQs are calculated by dividing an estimated environmental concentration (EEC) by a toxicity endpoint (*i.e.*, EEC/toxicity endpoint). This is a way to determine if an estimated concentration is expected to be above or below the concentration associated with the toxicity endpoint. The RQs are compared to regulatory levels of concern (LOCs). The LOCs for non-listed species are meant to be protective of community-level effects. For acute and chronic risks to vertebrates, the LOCs are 0.5 and 1.0, respectively, and for plants, the LOC is 1.0. The acute and chronic risk LOCs for bees are 0.4 and 1.0, respectively. In addition to RQs, other available data (*e.g.*, incident data) can be used to help understand the potential risks associated with the use of the pesticide.

7.2 Modeling

Various models are used to calculate aquatic and terrestrial EECs (see **Table 7-1**). The specific models used in this assessment are discussed further below.

Table 7-1. List of the Exposure Models Used to Assess Risk.

Environment	Taxa of Concern	Exposure Media	Exposure Pathway	Model(s) or Pathway
Aquatic	Vertebrates/ Invertebrates (including sediment dwelling)	Surface water	Runoff and spray drift to water	PWC version 2.001[1]
	Aquatic Plants (vascular and nonvascular)			
Terrestrial	Vertebrate	Dietary items		T-REX version 1.5.2[2] -Kenaga nomoagram (for liquid foliar sprays) - LD_{50}/ft^2 index - ingestion of treated seeds calculations - ingestion of granules calculations
	Plants	Spray drift/runoff	Runoff and spray drift to plants	TERRPLANT version 1.2.2
	Bees and other terrestrial invertebrates	Contact Dietary items	Spray contact and ingestion of residues in/on dietary items as a result of direct application	BeeREX version 1.0

[1] The Pesticide in Water Calculator (PWC) is a Graphic User Interface (GUI) that estimates pesticide concentration in water using the Pesticide Root Zone Model (PRZM) and the Variable Volume Water Model (VVWM). PRZM-VVWM.

[2] The Terrestrial Residue Exposure (T-REX) Model is used to estimate pesticide concentration on avian and mammalian food items. For liquid applications to bare soil, arthropod and seed residues estimated from the Kenaga nomogram are possible dietary exposure routes on the field and foliar residues estimate exposure adjacent to the field and that may occur with spray drift. In general, if the use pattern is not expected to have spray drift and foliage is not expected on the field, the foliar dietary numbers from the liquid applications to bare soil are not applicable.

Environment	Taxa of Concern	Exposure Media	Exposure Pathway	Model(s) or Pathway

8 Aquatic Organisms Risk Assessment

8.1 Aquatic Exposure Assessment

8.1.1 Modeling

Surface water aquatic modeling was simulated using the Pesticide in Water Calculator (PWC version 2.001). Chemical input parameters used in modeling are presented in **Table 8-1** and were calculated for parent alone as it is the single ROC based on information described in **Section 5.** Input parameters are specified in **Table 8-2** based on the use information described in **Section 3.2.** Input parameters were selected in accordance with EFED's guidance documents (USEPA, 2009b; USEPA, 2010b; USEPA, 2012b; USEPA, 2013a; USEPA, 2013b; USEPA, 2014a; USEPA, 2014b; USEPA and Health Canada, 2012).

The single currently registered use on ornamentals allows only for ground (handheld and backpack sprayer) applications of a flowable material to containerized ornamentals and bedding plants in greenhouses (indoors) and shadehouses (outdoors). Chlormequat chloride is not registered for applications to ornamentals grown in the field. Applications were modeled to represent three applications to potted plants, with three growing/production cycles per year.

Since the previous ecological risk assessment was completed, new aerobic soil metabolism, aerobic aquatic metabolism, and anaerobic aquatic metabolism data are available. These new data were incorporated into the risk assessment and resulted in some changes in the aquatic modeling half-life input values. Aerobic soil half-lives reflect only parent compound degradation now, as unextracted residues were not included in half-life calculations as in past assessments which used a TR approach. Newly submitted data were obtained from studies which used exhaustive extraction (*i.e.*, multiple extractants with a range of dielectric constants) and demonstrated that the remaining unextracted residues in the soil or sediment samples could be considered bound for exposure/risk assessment purposes. Additionally, it is now recommended that the daily average value be used to calculate acute risk quotients for aquatic organisms rather than the peak value used in previous risk assessments (USEPA, 2017). The model inputs for chlormequat chloride half-lives generally increased with the newly available data because the newly available data resulted in higher representative half-life inputs than previously calculated values. Additionally, the modeling input for sorption is now derived from K_d values instead of K_{oc} as done in past assessments. As chlormequat chloride is a cation, the K_{oc} model is not valid for determining mobility in soils.

Table 8-1. Aquatic Modeling Input Parameters for Chemical Tab for Chlormequat Chloride.

Parameter (units)	Value (s)	Source	Comments
K_d(mL/g)	4	MRIDs 46715228, 46715229	Mean of 7 values for parent. Because it is a cation, the K_{oc} is not a valid model for sorption. Study was at 10°C instead of 20°C.
Water Column Metabolism Half-life (days) at 20°C	836.9	MRID 50747528	Represents the 90 percent upper confidence bound on the mean of 2 representative half-life values from an aerobic aquatic metabolism study.
Benthic Metabolism Half-life (days) at 20°C	75,165	MRID 50747529	Represents the 90 percent upper confidence bound on the mean of 2 representative half-life values from an anaerobic aquatic metabolism study.
Aqueous Photolysis Half-life (days)@ pH 7	0	MRID 47769404	Stable to photolysis in water.
Hydrolysis Half-life (days)	0	MRID 47769403	No significant degradation observed at 50°C.
Soil Half-life (days) at 20°C	271.9	MRID 50747527	Represents the 90 percent upper confidence bound on the mean of 4 representative half-life values from an aerobic soil metabolism study. MRID 46715225 data are from foreign soils and are not used in modeling; data indicate a different degradation profile compared with domestic soils.
Foliar Half-life (days)	--	--	No Data
Molecular Weight (g/mol)	158.1	--	--
Vapor Pressure (Torr) at 20°C	7.5×10^{-8}	USEPA 2007; DP336709	--
Solubility in Water (mg/L)	1×10^{6} mg/L	MRID 46686204	20°C

[1] Other input parameters for the applications tab are shown in **Table 8-2**

Pesticide in Water Calculator scenarios are used to specify soil, climatic, and agronomic inputs in the Pesticide Root Zone Model (PRZM) and are intended to result in high-end water concentrations associated with a particular crop and pesticide within a geographic region. Each PWC scenario is specific to a vulnerable area where the specified crop is commonly grown. Soil and agronomic data specific to the location are built into the scenario, and a specific climatic weather station providing 30 years of daily weather values is associated with the location. **Table 8-2** identifies the use site associated with the PRZM scenarios.

BEAD provided the application rates simulated based on information on the labels. Chlormequat chloride is used only on potted plants grown in greenhouses and in shadehouses, with some of the plants grown in shadehouses being treated with the pesticide prior to being moved outdoors. While none of the potted plants are planted and treated in the field, the only available scenario that represents the ornamentals use are for nursery plants grown in the field. In previous assessments, the turf scenarios were used in modeling as surrogates (prior to the development of nursery standard scenarios) because they consist of high organic matter topsoil layers that are similar to soils used for bedding plants in nurseries. In the current assessment, however, all available nursery scenarios are used as surrogates for modeling to conservatively represent the outdoor use of chlormequat chloride on containerized ornamentals in shadehouses. While treated plants are produced in different production cycles (three per year, with three pesticide applications per crop cycle based on label restrictions) and potted plants are removed from the shadehouses and replaced with the next set of plants, modeling was conducted using nine total applications per year since the treated plants occupy the same ground space in the shadehouse regardless of the crop cycle in which they are treated.

Table 8-2. PWC Input Parameters Specific to Use Patterns for Chlormequat Chloride (Applications Tab and Crop/land Tab).

Use Site	PWC Scenario	Date of Initial App.	App. Rate in lbs a.i./A (kg a.i./ha)	# App. per Year	App. Interval (days)	App Method	Application Efficiency/Spray Drift Fraction
Nursery	CAnurserySTD_V2	14 days post-emergence	3.7 (4.14)	9 (3 applic. per crop cycle with 3 cc per yr.)	5	Above crop	Ground spray 0.99/0.062
	MInurserySTD_V2						
	FLnurserySTD_V2						
	NJnurserySTD_V2						
	ORnurserySTD_V2						
	TNnurserySTD_V2						

Table 8-3. Surface Water EECs for Chlormequat Chloride (Estimated Using PWC version 2.001).

Use	PWC Scenario	Annual App Rate lbs a.i./A, App type	1-in-10 year mean EEC				
			Water Column (µg/L)			Pore-Water (µg/L)	
			1-day	21-day	60-day	1-day	21-day
Nursery	CAnurserySTD_V2	3.7, ground	840	835	824	1199	1105
	MInurserySTD_V2		1687	1682	1678	1639	1637
	FLnurserySTD_V2		1006	994	974	882	881
	NJnurserySTD_V2		**1843**	**1837**	**1828**	**1841**	**1830**
	ORnurserySTD_V2		1140	1133	1122	1082	1082
	TNnurserySTD_V2		1534	1525	1503	1467	1460

Maximum EECs are shown in **bold**.

8.1.2 Monitoring

The following databases and sources were searched for monitoring information on chlormequat chloride in January 2021:

- Water Quality Portal (USEPA *et al.*)[3]

[3] https://www.waterqualitydata.us/

- California Environmental Data Exchange Network (CEDEN) (State Water Resources Control Board, 2015)[4]
- California Department of Pesticide Regulation Surface Water Database[5] (CADPR, 2020)

Based on the search results, no monitoring data are available for chlormequat chloride. Additionally, the Agency is not aware of any other monitoring for chlormequat chloride conducted by federal or state agencies. The absence of monitoring data for chlormequat chloride cannot be construed as evidence that the compound is not moving into surface and/or groundwater.

8.2 Aquatic Organism Risk Characterization

Risk assessment integrates the results of the exposure and ecotoxicity data to evaluate the likelihood of adverse ecological effects. The means of this integration is called the risk quotient (RQ) method. Using a deterministic approach, RQs are calculated by dividing point estimates of exposure, *i.e.,* estimated environmental concentrations (EECs), by point estimates of acute or chronic toxicity values.

For evaluating potential risk to aquatic animals, acute RQs for freshwater and estuarine/marine fish and invertebrates are calculated using the 1-day mean EEC; chronic RQs for freshwater and estuarine/marine fish and invertebrates are calculated using the 60-day mean and 21-day mean, respectively. The RQs are then compared to Office of Pesticide Programs' (OPP) Levels of Concern (LOCs) for acute (LOC=0.5) or chronic risk (LOC=1.0). These LOCs are used by OPP to analyze potential risk to non-target organisms and the need to consider regulatory action. The EECs are based on residues of chlormequat chloride alone. Chlormequat chloride EECs and RQs are summarized in **Table 8-6** and **Table 8-7**.

The aquatic exposure component of the ecological risk associated with the use of chlormequat chloride was determined using standard modeling scenarios for nursery use. While the shadehouse use is considered an outdoor use, plants are only treated in pots with handheld or backpack sprayers and chlormequat is not directly applied to field grown plants in the ground. Thus, exposure estimates for aquatic risk may overestimate potential aquatic exposures.

8.2.1 Aquatic Vertebrates

Chlormequat chloride TGAI is classified as practically non-toxic to both freshwater (LC_{50} > 1,000,000 µg a.i./L) and estuarine/marine fish (E/M; LC_{50} >100,000 µg a.i./L), respectively, on an acute exposure basis. Since there were no significant effects up to the highest concentration tested and the acute toxicity endpoints are several orders of magnitude higher than the surface water EEC of 1,843 µg a.i./L, RQs were not calculated. Therefore, the likelihood of adverse

[4] http://www.ceden.org/
[5] http://www.cdpr.ca.gov/docs/emon/surfwtr/surfdata.htm

effects on fish from acute exposure to chlormequat chloride as a result of the currently registered use on ornamentals is expected to be low. Since freshwater fish serve as surrogates for aquatic-phase amphibians, the likelihood of adverse effects on aquatic-phase amphibians is also expected to be low as well.

Chronic toxicity endpoints for both freshwater (NOAEC =10,000 µg a.i./L) and E/M (NOAEC =9,150 µg a.i./L) fish are at least 5 times higher than the highest surface water EECs (1,828 µg a.i./L) and result in RQ values below the chronic risk LOC of 1.0. Therefore, the likelihood of adverse effects in freshwater and E/M fish as well as aquatic-phase amphibians from chronic exposure resulting from currently the registered use of chlormequat chloride is also considered low. This conclusion differs from the previous risk assessment (USEPA, 2006, DP Barcode D333104) where chronic risk to fish was assumed because of the absence of data for assessment.

8.2.2 Aquatic Invertebrates

Chlormequat chloride is characterized as practically non-toxic to freshwater invertebrates (EC_{50}=16,900 µg ai/L) and practically non-toxic to E/M crustaceans (LC_{50}>110,000 µg ai/L) on an acute exposure basis. Since toxicity studies with E/M crustaceans resulted in a non-definitive endpoint, the more sensitive and definitive toxicity endpoint for the Eastern oyster (IC_{50}=50,000 µg ai/L) is used to estimate risk to estuarine/marine invertebrates. RQs do not exceed the acute risk LOC of 0.5 for either freshwater or E/M invertebrates for any of the chlormequat chloride use scenarios evaluated (**Table 8-6**).

Chronic exposure of freshwater invertebrates resulted in a NOAEC of 5,000 µg ai/L above which there was a 20% reduction in live offspring at the LOAEC of 10,000 µg; whereas, chronic exposure of E/M crustaceans to chlormequat chloride did not detect any statistically significant effects up to the highest concentration tested (NOAEC=9,260 µg ai/L). Based on chronic exposure estimates, RQs do not exceed the chronic risk LOC of 1 for freshwater or estuarine/marine invertebrates exposed to chlormequat chloride (**Table 8-6**). Therefore, the likelihood of adverse effects on aquatic invertebrates from exposure to chlormequat chloride as a result of the currently registered use on ornamentals is expected to be low. This conclusion differs from the previous risk assessment (USEPA, 2006, DP Barcode D333104) where chronic risk to aquatic invertebrates was assumed because of the absence of data for assessment.

Table 8-4. Acute and Chronic Risk Quotients (RQs) for Aquatic Invertebrates Exposed to Chlormequat Chloride in the Water-Column.

Use Sites	1-in-10 Yr EEC (µg/L)		Risk Quotient			
			Freshwater		Estuarine/Marine	
	Daily Mean	21-day Mean	Acute[1]	Chronic[2]	Acute[1]	Chronic[2]
			EC_{50} = 16,900 µg a.i./L	NOAEC = 5,000 µg a.i./L	LC_{50} = 50,000 µg a.i./L	NOAEC = 9,260 µg a.i./L
NJnurserySTD_ V2	1,843	1,837	0.1	0.4	<0.1	0.2

Bolded values exceed the acute risk to non-listed species level of concern (LOC) of 0.5 or the chronic risk LOC of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] The estimated environmental concentrations (EECs) used to calculate this RQ are based on the 1-in-10-year peak 1-day average value from **Table 8-3**.

[2] The EECs used to calculate this RQ are based on the 1-in-10-year 21-day average value from **Table 8-3**.

8.2.3 Aquatic Plants:

Although vascular aquatic plants are roughly 80x more sensitive to chlormequat chloride than non-vascular aquatic plants, RQs do not exceed the LOC of 1.0 for risk to either vascular or non-vascular aquatic plants for any of the use scenarios evaluated. Therefore, the likelihood of adverse effects to aquatic plants from exposure as a result of the registered use of chlormequat chloride on ornamentals is expected to be low.

Table 8-5. Risk Quotients (RQs) for Non-listed Aquatic Plant Species Exposed to Chlormequat Chloride.

Use Sites	1-in-10 Year Daily Mean EEC (µg/L)	Risk Quotients	
		Vascular	Non-vascular
		IC_{50} = 2,600 µg a.i./L	IC_{50} > 207,000 µg a.i./L
NJnurserySTD_V2	1,843	0.7	<0.1

The level of concern (LOC) for risk to aquatic plants is 1. The toxicity endpoints listed in the table are those used to calculate the RQ.

9 Terrestrial Vertebrates Risk Assessment

9.1 Terrestrial Vertebrate Exposure Assessment

Terrestrial wildlife exposure estimates are typically calculated for birds and mammals by emphasizing the dietary exposure pathway. Since chlormequat chloride is applied outdoors in shadehouses via handheld or backpack sprayers, potential dietary exposure for terrestrial wildlife in this assessment is based on consumption of chlormequat chloride residues on food items following spray (foliar) using the Kenaga nomogram (Hoerger and Kenaga, 1972).

Risk to terrestrial vertebrates were assessed using both the maximum label rate of 3.7 lbs ai/A and well as a calculated per-acre equivalent spot treatment application rate of 8.24 lbs ai/A for use in shadehouses/nurseries based on input from the Biological and Economic Analysis Division (BEAD 2017). This estimated treatment rate is higher than the maximum label rate on a per acre basis; however, it is recognized that spot treatments only cover a very small area and applications for this purpose would not likely exceed the maximum per acre label rate. It is also noted that outdoor nurseries, shadehouses and greenhouses tend to be heavily managed areas in which extraneous plants are minimized to limit the extent to which forage/habitat is available for animals.

The EECs for mammals and birds (which are used as surrogates for reptiles and terrestrial-phase amphibians) from consumption of dietary items on the treated field were calculated with T-REX v.1.5.2, using a default foliar dissipation half-life of 35 days. An example of a T-REX output based on chlormequat exposure can be found in **Appendix C.** The default foliar dissipation half-life of 35 days was used because data on chlormequat chloride foliar dissipation half-lives are not available and the compound is stable to hydrolysis and photolysis in water so is not expected to degrade on leaf surfaces.

9.1.1 Dietary Items in the Treated Areas

For the foliar uses, EECs (**Table 9-1**) are based on registered application rates (8.24 lbs ai/A), number of applications (9), and re-application intervals (5) presented in **Table 3-1**.

Table 9-1. Summary of Dietary (mg a.i./kg-diet) and Dose-based Estimated Environmental Concentrations (EECs; mg a.i./kg-bw) as Food Residues for Birds, Reptiles, Terrestrial-Phase Amphibians and Mammals from Chlormequat Chloride Using the Application Rate for Spot Treatments (T-REX v. 1.5.2, Upper-Bound Kenaga).

Food Type	Dietary-Based EEC (mg/kg-diet)	Dose-Based EEC (mg/kg-body weight)					
		Birds			Mammals		
		Small (20 g)	Medium (100 g)	Large (1000 g)	Small (15 g)	Medium (35 g)	Large (1000 g)
Nursery (8.24 lbs a.i./acre; 9 applications with 5-day reapplication interval)							
Short grass	12,373	14,091	8,035	3,598	11,796	8,153	1,890
Tall grass	5,671	6,458	3,683	1,649	5,407	3,737	866.4
Broadleaf plants/small insects	69,604	7,926	4,520	2,024	6,635	4,586	1,063
Fruits/pods/seeds (dietary only)	773.3	880.7	502.2	224.8	737.3	509.6	118.1
Arthropods	4,846	5,519	3,147	1,409	4,620	3,193	740.4
Seeds (granivore)[1]	.	195.7	111.6	49.97	163.8	113.2	26.25
Nursery (3.7 lbs a.i./acre; 9 applications with 5-day reapplication interval)							
Short grass	5,556	6,327	3,608	1,615	5,297	3,661	848.8
Tall grass	2,546	2,900	1,654	740.4	2,428	1,678	389.0
Broadleaf plants/small insects	3,125	3,559	2,029	908.7	2,979	2,059	477.4
Fruits/pods/seeds (dietary only)	347.2	395.5	225.5	100.9	331.1	228.8	53.05
Arthropods	2,176	2,478	1,413	632.7	2,075	1,434	332.4
Seeds (granivore)[1]	.	87.88	50.11	22.44	73.57	50.85	11.79

[1] Seeds presented separately for dose-based EECs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

9.2 Terrestrial Vertebrate Risk Characterization

The RQ values are generated based on the upper-bound EECs discussed above and toxicity values contained in Table **6-2**. Risk to terrestrial organisms was assessed based on 9 applications of either the maximum single rate of 3.7 or the maximum extrapolated spot treatment rate of 8.24 lbs ai/A; based on a re-application interval of 5 days.

With an LD_{50} of 556 mg ai/kg bw, chlormequat chloride is classified as slightly toxic to birds on an acute oral exposure basis. Although three different species of birds were tested in subacute dietary toxicity studies, each resulted in non-definitive (>) toxicity values. Based on the highest dietary concentration tested, chlormequat chloride is classified as practically non-toxic to birds on a subacute dietary exposure basis (LC_{50}>3,175mg ai/kg diet). Based on these data, and using the extrapolated application rate of 8.24 lbs ai/A, dose-based RQs (0.2-33) exceed the acute risk LOC of 0.5 for small- (20 g) and medium-(100 g) sized birds feeding on short grass, tall grass, broadleaf plants, fruit/pods and arthropods (**Table 9-2**). Dose-based RQs (<0.1-4.7) for large- (1000 g) sized birds exceed the acute risk LOC birds feeding on short grass, tall grass, broadleaf plants and arthropods. Although, the sub-acute LC_{50} is non-definitive (>3,175mg a.i./kg diet) with no mortality at any treatment concentration, a conservative LC_{50} value of 3,175 mg a.i./kg diet was used to calculate RQ values. Based on this conservative value, dietary-based RQ values (<0.2-<3.9) exceed the acute risk LOC for birds feeding on short grass, tall grass, broadleaf plants and arthropods. Even when based on the maximum single rate of 3.7 lbs ai/A, the acute dose-based RQ values for all sized birds feeding on short grass, tall grass, broadleaf plants and arthropods exceed the acute risk LOC with RQ values ranging up to 15. The dietary-based RQ (0.1-1.7) for birds also exceeds the acute risk LOC for birds feeding on all food types except fruit/pods/seeds.

Based on the upper-bound Kenaga values for the maximum extrapolated rate of 8.24 lbs ai/A, dietary-based RQs (2-32) exceed the chronic risk LOC of 1 for birds foraging on short grass, tall grass, broadleaf plants, fruits/pods/seeds and arthropods (**Table 9-2**) when based on a NOAEC value 390 mg ai/kg diet. Even at the maximum single application rate of 3.7 lbs ai/A, dietary-based RQ values exceed the chronic risk LOC for birds foraging across all food types except fruits/pods/seeds, with RQ values ranging up to 14 (**Table 9-3**). Based on the mean Kenaga values and at an extrapolated application rate of 8.24 lbs ai/A, dietary-based RQs exceed the chronic risk LOC for birds feeding on all food types except fruits/pods/seeds. When the LOAEC of 658 mg ai/kg diet (at which there was a 5% reduction in the ratio of 14-day hatchlings to number hatched) is used for the risk estimation instead of the NOAEC, dietary-based RQs (based on an application rate of 8.24 lbs ai/A) exceed the chronic risk LOC for birds feeding on all food types. Therefore, there is a likelihood of adverse effects to birds from exposure as a result of the registered use of chlormequat chloride on ornamentals. This conclusion is consistent with the previous risk assessment (USEPA, 2006, DP Barcode D333104) for chlormequat chloride. The targeted nature of the application of chlormequat chloride in containers using handheld and backpack sprayers may limit the amounts of residues on food sources such as grasses and broadleaf plants. Also, the treated areas tend to be heavily managed limiting the extent to which forage/habitat may be available for animals. Therefore, the potential exposure to birds may be overestimated. The chronic risk LOC (based on the maximum extrapolated rate of 8.24 lbs ai/A) is exceeded for 90 days. Reducing the foliar half-life from 35 days to 1 day does not change the magnitude of the chronic RQ values.

Table 9-1. Acute and Chronic Risk Quotient (RQ) values for Birds, Reptiles, and Terrestrial-Phase Amphibians from Labeled Uses of Chlormequat Chloride (T-REX v. 1.5.2, Upper-Bound Kenaga).

Food Type	Acute Dose-Based RQ LD_{50} = 556 mg a.i./kg-bw			Acute Dietary-Based RQ LC_{50} = 3,175 mg a.i./kg-diet	Chronic Dietary RQ NOAEC = 390 mg a.i./kg-diet
	Small (20 g)	Medium (100 g)	Large (1000 g)		
Nurseries and shadehouses (8.24 lb a.i./acre 9 app with 5-day reapplication interval)					
Herbivores/Insectivores					
Short grass	**33**	**15**	**4.7**	**<3.9**	**32**
Tall grass	**15**	**6.8**	**2.2**	**<1.8**	**14**
Broadleaf plants	**19**	**8.3**	**2.6**	**<2.2**	**18**
Fruits/pods/seeds	**2.1**	**0.9**	0.3	<0.2	**2.0**
Arthropods	**13**	**5.8**	**1.8**	**<1.5**	**12**
Granivores					
Seeds[1]	0.5	0.2	<0.1	NA	NA
Nurseries and shadehouses (3.7 lbs a.i./acre x 9 app with 5-day reapplication interval)					
Herbivores/Insectivores					
Short grass	**15**	**6.7**	**2.1**	**1.7**	**14**
Tall grass	**6.82**	**3.1**	1.0	**0.8**	**6.5**
Broadleaf plants	**8.4**	**3.8**	**1.2**	1.0	**8.0**
Fruits/pods/seeds	**0.9**	0.4	0.1	0.1	0.9
Arthropods	**5.8**	**2.6**	**0.8**	**0.7**	**5.6**
Granivores					
Seeds[1]	0.2	0.1	<0.1	NA	NA

Bolded values exceed the acute risk to non-listed species level of concern (LOC) of 0.5 or the chronic risk LOC of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ.

[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

Chlormequat chloride is classified as moderately toxic (LD_{50}=487 mg/kg bw) to mammals on an acute oral exposure basis; chronic exposure resulted in a NOAEL of 86.4 mg/kg bw above which there were reductions in parental growth (body weight) and number of offspring at the LOAEL of 255 mg ai/kg bw. Based on the extrapolated application rate of 8.24 lbs ai/A, acute dose-based RQs (0.07-11) for mammals exceed the acute risk LOC of 0.5 for small-(15 g), medium-(35 g) and large- (1000 g) sized mammals foraging on short grass, tall grass, broadleaf plants and arthropods (**Table 9-3**). The acute dose-based RQs also exceed the acute risk LOC for small- and medium-sized mammals foraging on fruit/pods. Even when based on the maximum single application rate of 3.7 lbs ai/A, dose-based RQs (<0.01-4.9) exceed the acute risk LOC for small- medium- and large-sized mammals feeding on short grasses, tall grasses, broadleaf plants and arthropods.

Table 9-2. Acute Risk Quotient (RQ) values for Mammals from Labeled Use of Chlormequat Chloride (T-REX v. 1.5.2, Upper-Bound Kenaga).

Food Type	Acute Dose-Based RQ LD_{50} = 487 mg a.i./kg-bw		
	Small (15 g)	Medium (35 g)	Large (1000 g)
Nurseries and shadehouses (8.24 lbs a.i./acre; 9 app with 5-day reapplication interval)			
Herbivores/Insectivores			
Short grass	**11**	**9.4**	**5.0**
Tall grass	**5.0**	**4.3**	**2.3**
Broadleaf plants	**6.2**	**5.3**	**2.8**
Fruits/pods/seeds	**0.7**	**0.6**	0.3
Arthropods	**4.3**	**3.7**	**2.0**
Granivores			
Seeds[1]	0.1	0.13	0.1
Nurseries and shadehouses (3.7 lbs a.i./acre; 9 app with 5-day reapplication interval)			
Herbivores/Insectivores			
Short grass	**4.9**	**4.2**	**2.3**
Tall grass	**2.3**	**1.9**	**1.0**
Broadleaf plants	**2.8**	**2.4**	**1.3**
Fruits/pods/seeds	0.3	0.3	0.1
Arthropods	**1.9**	**1.7**	**0.9**
Granivores			
Seeds[1]	0.1	0.1	<0.1

Bolded values exceed the acute risk to non-listed species level of concern (LOC) of 0.5. The toxicity endpoint listed in the table is that used to calculate the RQ.

[1] Seeds presented separately for dose – based EECs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

NC: Not calculated

Based on a NOAEL of 86.4 mg ai/kg bw and on the upper-bound Kenaga values for the maximum extrapolated rate of 8.24 lbs ai/A, dose-based RQs (0.4-62) also exceed the chronic risk LOC of 1 for all sized mammals foraging on short grass, tall grass, broadleaf plants, fruit/pods and arthropods (**Table 9-4**). Even when based on the maximum single application rate of 3.7 lbs ai/A, RQ values (0.2-28) exceed the chronic risk LOCs for all sized mammals foraging on short grass, tall grass, broadleaf plants and arthropods. When based on the mean Kenaga values and the maximum extrapolated spot treatment rate of 8.24 lbs ai/A, dose-based RQs range up to 22 and still exceed the chronic risk LOC. Even if dose-based RQ values were based on the LOAEL value of 255 mg/kg-bw instead of the NOAEL, chronic RQ values would range up to 21 and exceed the chronic risk LOC.

Using a NOAEC of 1,728 mg ai/kg diet, dietary-based RQs (0.4-7.2) for the extrapolated application rate of 8.24 lbs ai/A exceed the chronic risk LOC for mammals foraging on all food types assessed except fruits/pods/seeds (**Table 9-4**). Dietary-based RQs (0.2-3.2) for the application rate of 3.7 lbs ai/A exceed the chronic risk LOC for mammals foraging on all food types except fruit/pods/seeds. Therefore, there is a likelihood of adverse effects (5-24% reduction in body weight for generation and F_1 parents, and 34% reduction in litter size) to mammals from exposure as a result of the registered use of chlormequat chloride, which is consistent with the previous risk assessment (USEPA, 2006, DP barcode D333104). As mentioned earlier, the targeted nature of the application of chlormequat chloride in containers using handheld and backpack sprayers and the fact that nurseries tend to be managed to limit the extent to which animals and non-target plants would have forage/habitat may limit the amounts of residues on food sources such as grasses and broadleaf plants. Therefore, the potential exposure to mammals may be overestimated. The chronic LOC is exceeded by dietary-based RQs for 140 days based on the maximum extrapolated rate of 8.24 lbs ai/A. When based on mean Kenaga values, dietary-based RQs for the application rate of 8.24 lbs ai/A exceed chronic risk LOC for short grass, tall grass, broad leaf plants and arthropods. If the LOAEC is used to calculate the RQ instead of the NOAEC, dietary-based RQs (0.1-2.4) still exceed the chronic risk LOC for mammals foraging on short grass, tall grass and broadleaf plants. Similar to birds, reducing the foliar half-life from 35 days to 1 day does not change the magnitude of the RQs. Reducing the extrapolated application rate by about 99% (*i.e.,* from 8.24 to 0.1 lbs a.i/acre) would reduce RQ values for all birds and mammals below the acute and chronic risk LOCs based on upper-bound Kenaga numbers.

Even when based on the typical application rate of 1.57 lbs ai/A, and assume a single cycle, acute and chronic RQ values still exceed risk LOCs for both birds and mammals.

Table 9-3. Chronic Risk Quotient (RQ) values for Mammals from Labeled Use of Chlormequat Chloride (T-REX v. 1.5.2, Upper-Bound Kenaga).

Food Type	Chronic Dose-Based RQ NOAEL = 86.4 mg a.i./kg-bw			Chronic Dietary RQ NOAEC = 1,728 mg a.i./kg-diet
	Small (15 g)	Medium (35 g)	Large (1000 g)	
Nurseries and shadehouses (8.24 lbs a.i./acre)				
Herbivores/Insectivores				
Short grass	**62**	**53**	**28**	**7.2**
Tall grass	**28**	**24**	**13**	**3.3**
Broadleaf plants	**35**	**30**	**16**	**4.0**
Fruits/pods/seeds	**3.9**	**3.3**	**1.8**	**0.4**
Arthropods	**24**	**21**	**11**	**2.8**
Granivores				
Seeds[1]	0.9	0.7	0.4	N/A
Nurseries and shadehouses (3.7 lbs a.i./acre)				
Herbivores/Insectivores				
Short grass	**28**	**24**	**13**	**3.2**
Tall grass	**13**	**11**	**5.9**	**1.5**
Broadleaf plants	**16**	**13**	**7.2**	**1.8**
Fruits/pods/seeds	**1.7**	**1.5**	0.8	0.2
Arthropods	**11**	**9.3**	**5.0**	**1.3**
Granivores				
Seeds[1]	0.4	0.3	0.2	N/A

Bolded values exceed the chronic risk level of concern (LOC) of 1.0. The toxicity endpoints listed in the table are those used to calculate the RQ. N/A=not applicable.

[1] Seeds presented separately for dose – based RQs due to difference in food intake of granivores compared with herbivores and insectivores. This difference reflects the difference in the assumed mass fraction of water in their diets.

10 Terrestrial Invertebrate Risk Assessment

10.1 Bee Exposure Assessment

Chlormequat chloride is classified as practically non-toxic to adult honey bees on both an acute contact (LD_{50} >65 µg ai/bee) and oral (LD_{50}>100 µg ai/bee) exposure basis; the compound is also classified as practically non-toxic to larval honey bees on an acute exposure basis with an LD_{50}>91.2 µg ai/bee. Chronic exposure of adult bees resulted in a NOAEL of 64 µg ai/bee/day based on a 41% decrease in survival at a LOAEL of 139 µg ai/bee/day. Honey bee larvae though were more sensitive to chlormequat chloride with a NOAEL of 2.5 µg ai/larva/day based on an 15% reduction in adult bee emergence at a LOAEL of 8.3 µg ai/larva/day.

The bee risk assessment framework utilizes honey bees as a surrogate for both *Apis* and non-*Apis* bees (USEPA *et al.*, 2014). The first step in the risk assessment framework is to consider if bees are likely to be exposed while foraging on a treated field either through dietary matrices (*e.g*., pollen/nectar of bee-attractive plants) or interception of spray droplets (contact). Most of the ornamental plants expected to be grown in nurseries are considered to be attractive sources of pollen and/or nectar for *Apis* bees and may represent potential exposure pathways for pollinators on the field. Although chlormequat chloride is a plant growth regulator that is applied to plants before bloom, the compound is systemic in plants and could be translocated to pollen/nectar and serve as a route of exposure for bees in the treatment area. The extent to which bees may be able to access plants in shadehouses and greenhouses may be limited; however, containerized plants in outdoor nurseries with unrestricted access could serve as route of exposure for bees. While off-field assessments are conducted for foliar sprays regardless of whether the crop is attractive or not, since chlormequat chloride must be applied via hand-held devices, the likelihood of exposure of bees off the treated field is considered low.

10.2 Bee Tier I Exposure Estimates

Contact and dietary exposure are estimated separately using different approaches specific for different application methods. The Bee-REX model (Version 1.0) calculates default (*i.e*., high end, yet reasonably conservative) EECs for contact and oral (dietary) routes of exposure from foliar applications. See **Appendix D** for a sample output from BeeREX for chlormequat chloride. Additional information on bee-related exposure estimates, and the calculation of risk estimates in BeeRex can be found in the *Guidance for Assessing Risk to Bees* (USEPA *et al.*, 2014). These EECs are then divided by acute (LD_{50}) and chronic (NOAEL) toxicity endpoints to derive RQs. Acute RQs are compared to an acute risk LOC of 0.4. For chronic risk, the LOC is 1.0.

In cases where the Tier I RQs exceed the acute and chronic risk LOCs, estimates of exposure may be refined using measured pesticide concentrations in pollen and nectar of treated crops, and further calculated for other castes of bees using their food consumption rates as summarized in the White Paper to support the Scientific Advisory Panel (SAP) on the pollinator risk assessment process (USEPA, 2012b).

10.3 Bee Risk Characterization (Tier I)

10.3.1 Tier I Risk Estimation (Contact Exposure)

On-Field Risk
Since potential exposure of bees is identified for chlormequat chloride use on the treated plants, the next step in the risk assessment process is to conduct a Tier 1 risk assessment. By design, the Tier 1 assessment begins with model-generated (for foliar) estimates of exposure via contact and oral (dietary) routes. For contact exposure, only the adult worker foragers (females) and drones (males) are considered since these bees spend time outside the colony; whereas, the queen and younger bees primarily remain within the hive (except during swarming events) and would be less subject to contact exposure. Furthermore, laboratory-based toxicity testing protocols have only been developed for adult bee contact exposures. Effects are defined by laboratory exposures to groups of individual bees (which serve as surrogates for solitary non-*Apis* bees and individual social non-*Apis* bees).

An acute contact honey bee study with chlormequat chloride TGAI reported non-definitive LD_{50} values of >65 µg a.i./bee. Since the LD_{50} value is non-definitive and higher than the highest dose tested, and about 10 times higher than the EEC, the likelihood of adverse effects on adult bees from acute contact exposure as a result of current uses is expected to be low.

10.3.2 Tier I Risk Estimation (Oral Exposure)

On-Field Risk
For oral exposure, the Tier 1 assessment considers just the caste of bees with the greatest oral exposure (foraging adults). If risks are identified, then other factors are considered for refining the Tier 1 risk estimates. These factors include other castes of bees and available information on residues in pollen and nectar which is deemed applicable to the crops of interest. These exposure data may have been collected on surrogate crops (*e.g.*, phacelia, buckwheat, alfalfa) which are known to be attractive sources of both pollen and nectar for bees.

Since the acute LD_{50} values are non-definitive and higher than the highest dose tested, and about 100 times higher than the EEC based on the maximum extrapolated application rate of 8.24 lbs ai/A, the likelihood of adverse effects on either adult or larval bees from acute oral exposure as a result of existing use of chlormequat chloride is expected to be low.

At the extrapolated application rate of 8.24 lbs ai/A, the chronic RQ (4.1) for adult honey bees exceeds the chronic risk LOC of 1 based on a 41% increase in adult bee mortality (NOAEL=64 µg a.i./bee/d). The chronic RQ (45) for larval honey bees also exceeds the chronic risk LOC based on a 15% reduction in adult emergence (NOAEL=2.5 µg a.i./bee/d). Even at the maximum label rate of 3.7 lbs ai/A, chronic RQ values for adults and larvae are 1.9 and 20, respectively, and exceed the chronic risk LOC. Therefore, there is a potential for adverse effects on both larval and adult honey bees from chronic exposure to chlormequat chloride on the treated field. Although using the LOAEL instead of the NOAEL to calculate the RQs changes the magnitude of the RQs, they still exceed the chronic risk LOC for both larval and adult honey bees at the extrapolated rate of 8.24 lbs ai/A. As noted earlier, chlormequat chloride is a plant growth regulator that is applied to plants before bloom; however, the compound is systemic in plants and could be translocated to pollen/nectar and serve as a route of exposure for bees in the treatment area. The extent to which bees may be able to access plants in shadehouses and greenhouses may be limited; however, containerized plants in outdoor nurseries with unrestricted access could serve as route of exposure for bees. Although chlormequat chloride residues may be washed from foliage following handheld or backpack sprayer application, the controlled and directed nature of this type of application would likely minimize spray drift. Therefore, off-site transport resulting from these applications was not considered a significant exposure pathway for this Tier 1 estimation. There are no honey bee incidents reported on the Incident Data System (IDS) for chlormequat chloride.

Table 10-1. Tier 1 (Default) Chronic Dietary-based Risk Quotients (RQs) for Adult Nectar Forager and Larval Worker Honey Bees (*Apis mellifera*) from BeeRex (ver. 1.0).

Use Pattern	Max. Single Appl. Rate	Bee Caste/Task	Unit Dose (μg a.i./bee per 1 lb a.i./A)	Oral Dose (μg a.i./bee)	Chronic Oral RQ[1]
Nurseries	8.24 lb a.i./A	Adult nectar forager	32	265	**4.1**
		Larval worker	14	112	**45**
Nurseries	3.7 lb a.i./A	Adult nectar forager	32	119	**1.9**
		Larval worker	14	50.3	**20**

Bolded RQ value exceeds the chronic risk level of concern (LOC) of 1.0.

[1] Based on a 10-d chronic NOAEL of 64 μg a.i./bee/d for adults (MRID 50747511) and a 22-d chronic NOAEL of 2.5 μg a.i./bee/d for larvae (MRID 50747512).

11 Terrestrial Plant Risk Assessment

11.1 Terrestrial Plant Exposure Assessment

The EECs for terrestrial plants are calculated using TERRPLANT v.1.2.2. The EECs were estimated using a single application for which TERRPLANT evaluates exposure via spray drift and runoff. Chlormequat chloride residues may be washed from foliage following spot treatment from handheld or backpack sprayer applications. Furthermore, although the controlled and directed nature of backpack sprayer applications would likely minimize spray drift, exposure via this route cannot be completely ruled out. In the RQ table, the runoff RQs for dryland and semi-aquatic areas are relying upon the summation of the exposure from drift and runoff.

Additionally, the spray drift RQs rely only on the spray drift estimated exposure. It is important to note that for spray drift, the TERRPLANT exposure estimate corresponds to an equivalent AgDrift™ estimated deposition for fine-medium droplets at approximately 200 feet from the edge of the treated field. For runoff, there are a few assumptions regarding the ratio of treated area to receiving non-target area that have an impact on the exposure estimation. In a dry area adjacent to the treatment area, exposure is estimated as sheet runoff. Sheet runoff is the amount of pesticide in water that runs off of the soil surface of a target area of land that is equal in size to the non-target area (1:1 ratio of areas). This differs for semi-aquatic areas, where runoff exposure is estimated as channel runoff. Channel runoff is the amount of pesticide that runs off of a target area 10 times the size of the non-target area (10:1 ratio of areas).

Exposures from runoff and spray drift are compared to measures of survival and growth (*e.g.*, effects to seedling emergence and vegetative vigor) to develop RQ values. Resulting upper-bound exposure estimates to terrestrial and semi-aquatic (wetland) plants adjacent to the treated field are in **Table 11-1**. The EECs are based on the maximum single application rate for terrestrial uses, solubility (10^6 mg/L), and spray drift fraction (*i.e.*, 1% for ground applications). The EECs represent residues from off-site exposure via spray drift and/or run-off to non-target plants found near application sites.

Table 11-1. TerrPlant-Calculated Estimated Environmental Concentrations (EECs) for Terrestrial and Semi-Aquatic Plants near Chlormequat Chloride Terrestrial Use Areas.

Use Site	Single Max. Application Rate (lb a.i./A)	EECs (lb a.i./A)[1]		
		Ground[2]		
		Dry Areas (Total)	Semi-Aquatic Areas (Total)	Spray Drift
Nurseries	8.24	0.494	4.202	0.082
Nurseries	3.7	0.222	1.887	0.037

[1] Based on a runoff fraction of 0.05

[2] Based on a drift fraction of 1% (*i.e.*, 0.01).

11.2 Terrestrial Plant Risk Characterization

Terrestrial plants are sensitive to chlormequat chloride formulated end-use product Manipulator™ (56.9% active ingredient) containing chlormequat chloride as the sole active with effects detected at rates below the maximum registered application rates and at which there were 6-20% reduction in plant height. The IC_{25} values for the seedling emergence test are 1.7 and >2.6 lbs a.i./acre for dicots and monocots, respectively. The IC_{25} values for the vegetative vigor tests are >3.0 lbs a.i./acre for both dicots and monocots. These toxicity estimates are at least 3 times higher than the EECs for dry areas and spray drift up to 200 feet, indicating low likelihood of adverse effects on terrestrial plants from exposure to chlormequat chloride at the maximum application rate in these areas. However, the IC_{50} values are either lower or potentially lower than the EECs for semi-aquatic areas. To assess potential risk to plants in semi-aquatic areas, a conservative IC_{25} value of 3 lbs a.i./acre was used for all the non-definitive IC_{25} values. Based on the most sensitive monocots and dicots and an extrapolated application rate of 8.24 lbs ai/A, RQs exceed the LOC of 1 for risk to terrestrial plants in semi-aquatic areas with RQ values of <1.6 and <2.5 for monocots and dicots, respectively. However, based on the most sensitive monocots and dicots and an application rate of 3.7 lbs ai/A, RQs (<1.1) only exceeds the LOC of 1 for risk to dicot terrestrial plants in semi-aquatic areas. Using endpoints from the supplemental plant test with TEP (BAS 062 03 W) results in similar LOC exceedances. It should be noted that exposure to non-target terrestrial plants in nurseries and shadehouses is likely to be limited by the controlled spraying of targeted plants in containers with backpack or handheld sprayers and these areas are typically managed to limit non-target plant growth. Therefore, potential exposure may likely be overestimated in this assessment. However, if exposed, there is a likelihood that terrestrial plants will be adversely affected from the registered use of chlormequat chloride. This is consistent with chlormequat chloride being a plant growth regulator.

Table 11-2. Risk Quotients (RQs) for Non-listed Terrestrial Plant Exposed to Chlormequat Chloride.

Type of Plant	Ground Spray RQs		
	Dry Areas	Semi-Aquatic Areas	Spray Drift Only
Nurseries and shadehouses (8.24 lb a.i./acre)			
Monocot	0.2	**1.6**	<0.1
Dicot	0.3	**2.5**	<0.1
Nurseries and shadehouses (3.7 lb a.i./acre)			
Monocot	<0.1	0.7	<0.1
Dicot	0.1	**1.1**	<0.1

Bolded RQ values exceed the LOC of 1.0 for risk to terrestrial plants.

A search of the EPA's Incident Data System (IDS) for ecological incidents on January 25, 2021, identified no incident reports for chlormequat chloride. However, incidents may have occurred due to chlormequat chloride exposures but may not have been reported due to various factors. Therefore, the lack of incident reports does not necessarily indicate the absence of incidents.

12 Conclusions

Given the use of chlormequat chloride and the its environmental fate properties (**Table 12-1**), there is a likelihood of exposure of chlormequat chloride to non-target terrestrial and aquatic organisms. Because chlormequat chloride is applied outdoors only to potted plants, there is a limited exposure pathway for aquatic risk due to the use pattern. While the shadehouse use is considered an outdoor use, because plants are only treated in pots and chlormequat is not directly applied to field grown plants in the ground, exposure estimates for aquatic risk may overestimate potential aquatic exposures. Even with conservatives estimates of aquatic exposure, however, no aquatic risks were identified.

When used in accordance with the label, such exposure may result in adverse effects upon the survival, growth, and reproduction of non-target terrestrial organisms. Consistent with previous risk assessments (USEPA, 2007), there is a potential for direct adverse effects to mammals, birds, reptiles, terrestrial-phase amphibians, terrestrial invertebrates, and terrestrial plants from exposure to chlormequat chloride as a result of the registered use on ornamentals. These risks were mostly based on exposure via spray drift and/or run-off. However, since exposure to non-target organisms in nurseries and shadehouses via spray drift and/or run-off is likely to be limited by the controlled spraying of targeted plants in containers using only handheld or backpack sprayers and these areas are typically managed to limit non-target plant growth, potential exposure in this assessment may likely be overestimated. Potential for direct adverse effects was identified for terrestrial invertebrates in this assessment but was not assessed in the previous risk assessment because of lack of data. A more in-depth summary of the risk conclusions is available in the Executive Summary Section 1.

Table 12-1. Potential Environmental Fate Concerns Identified for Chlormequat Chloride.

Bioconcentration/ Bioaccumulation[1]	Groundwater Contamination	Sediment	Persistence[2]	Residues of Concern	Volatilization
No, log K_{ow}<3	No	No	Yes	Parent	No

[1] Based on K_{ow} Based Aquatic Bioaccumulation Model (KABAM) for chemicals with a log K_{ow} >3.

[2] Persistence classification for parent compound, consistent with Goring *et al* (1975) applied to aerobic soil metabolism studies. Persistence is defined here as having a half-life of >180 days in aerobic soil.

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123259 or 138717	2019727	Fletcher, D. (1972) Report: 8-day Dietary LC_{50} Study with Cycocel Technical, 98% Pure in Ringneck Pheasants: IBT No. J1780. (Unpublished study received 1972 under 4G1461; prepared by Industrial Bio-Test Laboratories, Inc., submitted by American Cyanamid Co., Princeton, NJ; CDL:093893-R)
123260 or 125199 or 138718	2019728	Fletcher, D. (1972) Report: 8-day Dietary LC_{50} Study with Cycocel Technical, 98% Pure in Mallard Ducks: IBT No. J1779. (Unpublished study received 1972 under 4G1461; prepared by Industrial Bio-Test Laboratories, Inc., submitted by American Cyanamid Co., Princeton, NJ; CDL:093893-S)
46715212	2052851	Suresh, T. (1993) Avian Dietary (8 Days) Toxicity Study with Chlormequat-Chloride 720 g/L in Japanese Quail. Project Number: TOXI/1177/QU/AD, 1993/1002324. Unpublished study prepared by Rallis Research Centre, Rallis India. 22 p.
46715213	2052852	Gallagher, S.; Grimes, J.; Beavers, J. (2001) Chlormequat Chloride (CCC): A Dietary LC_{50} Study with the Mallard. Project Number: 514/101, 2001/1006190. Unpublished study prepared by Wildlife International, Ltd. 48 p.
46715214	2052853	Mitchell, L.; Beavers, J.; Jaber, M. (2001) Chlormequat Chloride (CCC): A Reproduction Study with the Japanese Quail. Project Number: 2001/1006189, 514/102. Unpublished study prepared by Wildlife International, Ltd. 153 p.
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		formerly *Salmo gairdneri*). (Unpublished study received 1972 under 4G1461; prepared by Bionomics, Inc., submitted by American Cyanamid Co., Princeton, NJ; CDL:093893-T)
37483	See 123261	Sleight, B.H., III (1972) The Acute Toxicity of Cycocel® and Experimental Insecticide AC 92,100 to Bluegill (*Lepomis macrochirus*) and Rainbow Trout (*Oncorhynchus mykiss* formerly *Salmo gairdneri*). (Unpublished study received Apr 9, 1973 under 3G1340; prepared by Bio- nomics, Inc., submitted by American Cyanamid Co., Princeton, N.J.; CDL:093584-U)
138719	2019733	Mueller. (1981) Determination of the Acute Toxicity of Chlormequat- chloride BAS 062-W to the Waterflea *Daphnia magna* Straus. (Un- published study received Feb 28, 1984 under 241-EX-103; prepared by BASF AG, submitted by American Cyanamid Co., Princeton, NJ; CDL:072394-G)
124064	2019734	Heitmuller, T. (1975) Acute Toxicity of Cycocel to Eastern Oysters (*Crassostrea virginica*), Pink Shrimp (*Penaeus duorarum*) and Fiddler Crabs (*Uca pugilator*). (Unpublished study received Mar 15, 1976 under 6F1759; prepared by Bionomics, EG & G, Inc., submitted by American Cyanamid Co., Princeton, NJ; CDL:095139-I)
46715215	2052854	Thun, S. (1993) 21 D Reproduction Test in Daphnia, Test Article: "Chlormequat Chloride". Project Number: 80/91/2309/05/93, 1993/1002328. Unpublished study prepared by IBR Forschungs Gmbh. 80 p.
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46715217	2052856	Thun, S. (1993) Prolonged Toxicity Test in the Rainbow Trout (Oncorhynchus mykiss) Test Article: "Chlormequat Chloride". Project Number: 80/91/2309/04/93, 1993/1002327. Unpublished study prepared by IBR Forschungs Gmbh. 49 p.
46715218	2052857	Bogers, M. (1991) 21-Day Prolonged Toxicity Study with Stabilan in the Rainbow Trout. Project Number: 1250/FP9//001046, 1991/1002363. Unpublished study prepared by RCC Umweltchemie Ag and Notox B.V. 38 p.

47769401	2084676	Munk, R. (1991) Sublethal Toxic Effects on the Rainbow Trout (Oncorhynchus mykiss WALBAUM 1792) of Chlormequat-Chloride in a Flow-Through System (28 Days). Project Number: 42F0349/905051, 1991/10109, PCP01274. Unpublished study prepared by BASF Aktiengesellschaft. 57 p.
47769402	Request for a Waiver 2084675-denied	Holmes, C. (2009) Chlormequat Chloride: Request for a Waiver for the Conduct of a Freshwater Fish Early Life Stage Study. Project Number: 2009/7003180. Unpublished study prepared by BASF Corporation. 6 p.
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46715220	2052859	Frank, P. (2001) BAS 062 03 W: A Toxicity Test to Determine the Effects of the Test Item on Vegetative Vigor of Terrestrial Plants: (Final Report). Project Number: 80035, 2001/1007667, BAS50. Unpublished study prepared by Staatliche Lehr- und Forschungsanstalt fuer. 49 p.
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46715222	2052861	Wuthrich, V. (1990) Acute Toxicity of Stabilan to *Scenedesmus subspicatus* (OECD - Algae Growth Inhibition Test). Project Number: 230624, 1990/7001881. Unpublished study prepared by RCC Umweltchemie Ag. 49 p.
46715224	2052863	Schmitzer, S. (1999) Laboratory Testing for Toxicity (Acute Contact and Oral LD_{50}) of CCC 750 on Honey Bees (*Apis mellifera* L.) (Hymenoptera, Apidae): (Final Report). Project Number: 6493036, 1999/1008202. Unpublished study prepared by Institut fuer Biologische Analytik und Consulting IBACON. 46 p.

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50747507 Stanfield, K. (2018) Chlormequat Chloride: Zebra Finch (*Taeniopygia guttata*) Dietary Acute Toxicity Test. Project Number: 141105/4100. Unpublished study prepared by Smithers Viscient Laboratories. 195p.

50747508 Bean, T. (2018) Chlormequat Chloride: Reproductive Toxicity Test with the Mallard (*Anas platyrhynchos*). Project Number: 14105/4102. Unpublished study prepared by Smithers Viscient Laboratories. 347p.

50747509 Bean, T. (2018) Chlormequat Chloride: Reproductive Toxicity Test with the Northen Bobwhite (*Colinus virginianus*). Project Number: 14105/4101. Unpublished study prepared by Smithers Viscient Laboratories. 417p.

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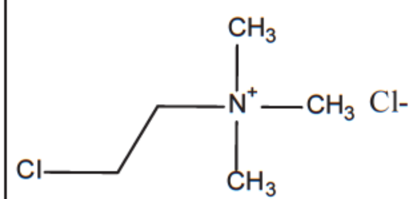
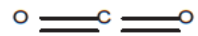
50747514 Kirkwood, A. (2017) Manipulator™- Seedling Emergence Test. Project Number: 14105/6101. Unpublished study prepared by Smithers Viscient Laboratories. 304p.

50747515 Kirkwood, A. (2017) Manipulator™- Vegetative Vigor Test. Project Number: 14105/6102. Unpublished study prepared by Smithers Viscient Laboratories. 258p.

Appendix A. ROCKS table

Table A1. Chemical Names and Structures of Chlormequat Chloride and its Transformation Products in Metabolism Studies

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (day)
PARENT COMPOUND						
Chlormequat chloride	**IUPAC:** (2-chloroethyl)trimethylammonium chloride **CAS:** 2-chloro-N,N,N-trimethylethanaminium chloride **CAS No.:** 999-81-5 **Formula:** $C_5H_{13}Cl_2N$ **MW:** 158.1 g/mol **SMILES:** ClCC[N+](C)(C)C.[Cl-]		Aerobic soil	46715225	–	3.3 (224
						15.6 (112)
						6.8 (112)
						8.2 (112)
				50747527		57.9 (120 d)
						78.4 (120 d)
						74.7 (120 d)
						63.3 (120 d)
			Aerobic aquatic	50747528		33.0 (100)
						68.9 (100)
			Anaerobic aquatic	50747529		60.6 (102)
						72.7 (102)
MAJOR (>10%) TRANSFORMATION PRODUCTS						
Unextracted residues	(not applicable)	(not applicable)	Aerobic soil	46715225	69.4% (224 d)	69.4% (224 d)
					61.1% (112 d)	61.1% (112 d)
					59.7% (112 d)	59.7% (112 d)
					28.3% (112 d)	28.3% (112 d)
				50747527	11.4% (120 d)	11.4% (120 d)
					9.7% (120 d)	9.7% (120 d)
					7.7 (120 d)	7.7 (120 d)
					14.9% (29 d)	12.5% (120 d)
			Aerobic aquatic	50747528	38.3% (56 d)	31.2% (100 d)
					20.3% (56 d)	17.5% (100 d)
			Anaerobic aquatic	50747529	42.9% (102 d)	42.9% (102 d)
					26.5% (102 d)	26.5% (102 d)
Carbon dioxide	Carbon dioxide		Aerobic soil	46715225	24.2% (112 d)	16.9% (224 d)

Code Name/ Synonym	Chemical Name	Chemical Structure	Study Type	MRID	Maximum %AR (day)	Final %AR (day)
	Formula: CO_2 **MW:** 44.1 g/mol SMILES: O=C=O				19.0% (112 d)	19.0% (112 d)
					25.3% (112 d)	25.3% (112 d)
					27.8% (112 d)	27.8% (112 d)
				50747527	29.3% (120 d)	29.3% (120 d)
					16.2% (120 d)	16.2% (120 d)
					23.6% (120 d)	23.6% (120 d)
					18.8% (120 d)	18.8% (120 d)
			Aerobic aquatic	50747528	41.6% (100 d)	41.6% (100 d)
					11.2% (100 d)	11.2% (100 d)
			Anaerobic aquatic	50747529	9.02% (102 d)	9.02% (102 d)
					0.45% (102 d)	0.45% (102 d)

ND= means "not detected". AR means "applied radioactivity". MW means "molecular weight".

Appendix B. Example Aquatic Modeling Output and Input Batch Files

Below is an example output summary file from a single PWC modeling simulation of foliar application to ornamentals. The batch file output is included below the output file for the NJ nursery application which resulted in the highest EECs.

Summary of Water Modeling of Chlormequat Chloride and the USEPA Standard Pond
Estimated Environmental Concentrations for chlormequat chloride are presented in Table B1 for the USEPA standard pond with the NJnurserySTD_V2 field scenario. A graphical presentation of the year-to-year acute values is presented in Figure B1. These values were generated with the Pesticide Water Calculator (PWC), Version 2.001. Critical input values for the model are summarized in Tables B2 and B3.
This model estimates that about 1.8% of chlormequat chloride applied to the field eventually reaches the water body. The main mechanism of transport from the field to the water body is by runoff (63.9% of the total transport), followed by spray drift (35.4%) and erosion (0.68%).
In the water body, pesticide dissipates with an effective water column half-life of 1244.5 days. (This value does not include dissipation by transport to the benthic region; it includes only processes that result in removal of pesticide from the complete system.) The main source of dissipation in the water column is metabolism (effective average half-life = 1244.5 days) followed by volatilization (9.721744E+09 days).
In the benthic region, pesticide dissipation is negligible (111771.7 days). The main source of dissipation in the benthic region is metabolism (effective average half-life = 111771.7 days). The vast majority of the pesticide in the benthic region (91.53%) is sorbed to sediment rather than in the pore water.

Table B1. Estimated Environmental Concentrations (ppb) for Chlormequat Chloride.

1-day Avg (1-in-10 yr)	1844.
4-day Avg (1-in-10 yr)	1842.
21-day Avg (1-in-10 yr)	1837.
60-day Avg (1-in-10 yr)	1828.
365-day Avg (1-in-10 yr)	1708.
Entire Simulation Mean	1362.

Table B2. Summary of Model Inputs for Chlormequat Chloride.

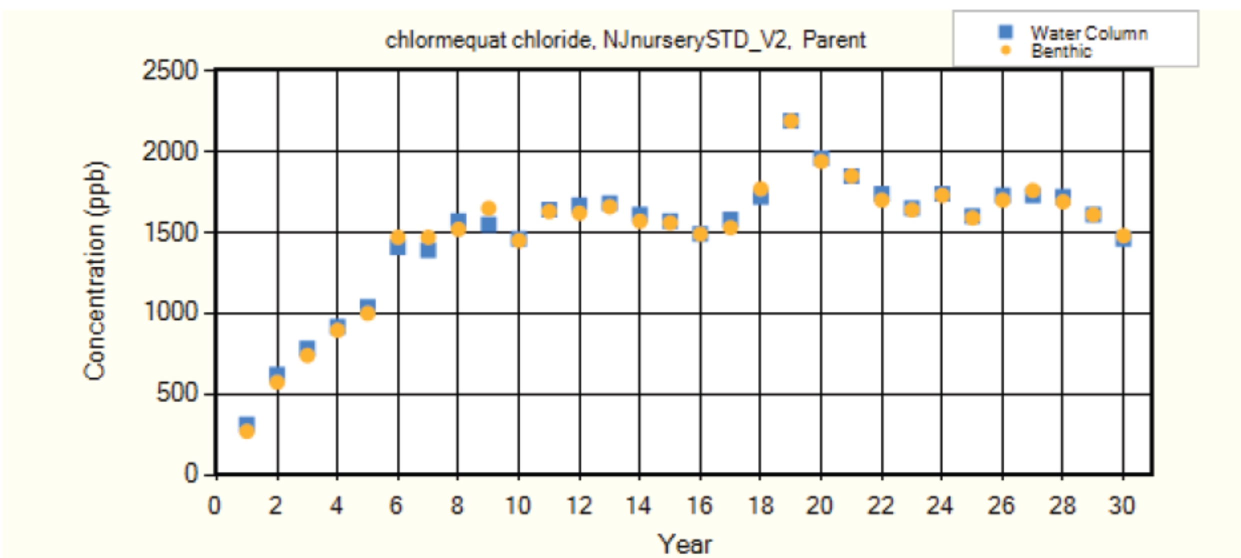
Scenario	NJnurserySTD_V2
Cropped Area Fraction	1
K_d (ml/g)	4
Water Half-Life (days) @ 20 °C	836.9

Benthic Half-Life (days) @ 20 °C	75165
Photolysis Half-Life (days) @ 40 °Lat	0
Hydrolysis Half-Life (days)	0
Soil Half-Life (days) @ 20 °C	271.9
Foliar Half-Life (days)	0
Molecular Weight	158.1
Vapor Pressure (torr)	7.5E-08
Solubility (mg/l)	1E06
Henry's Constant	6.38E-13

Table B3. Application Schedule for Chlormequat Chloride.

Date (Days Since Emergence)	Type	Amount (kg/ha)	Eff.	Drift
14	Above Crop (Foliar)	4.14	0.99	0.062
19	Above Crop (Foliar)	4.14	0.99	0.062
24	Above Crop (Foliar)	4.14	0.99	0.062
29	Above Crop (Foliar)	4.14	0.99	0.062
34	Above Crop (Foliar)	4.14	0.99	0.062
39	Above Crop (Foliar)	4.14	0.99	0.062
44	Above Crop (Foliar)	4.14	0.99	0.062
49	Above Crop (Foliar)	4.14	0.99	0.062
54	Above Crop (Foliar)	4.14	0.99	0.062

Figure B1. Yearly Highest 1-day Average Concentrations



Batch Run Results (maximum EECs in bold)

Scenario Name	1-d	4-d	21-d	60-d	90-d	365-d	Full	1-db	21-db
CAnurserySTD_V2_+0	840.3	839.4	834.7	824.4	816.1	758.4	595.8	1199	1105
MInurserySTD_V2_+0	1687	1686	1682	1678	1668	1559	1203	1639	1637
FLnurserySTD_V2_+0	1006	1004	994.4	973.6	955.9	801.3	623.7	881.7	880.8
NJnurserySTD_V2_+0	**1843**	**1842**	**1837**	**1828**	**1825**	**1708**	**1362**	**1841**	**1830**
ORnurserySTD_V2_+0	1140	1139	1133	1122	1114	1039	876.2	1082	1082
TNnurserySTD_V2_+0	1534	1531	1525	1503	1482	1338	1092	1467	1460

Appendix C. Output of Terrestrial Model for Chlormequat Chloride Exposure (T-REX v.1.5.2)

Upper Bound Kenaga Residues for RQ Calculation

Chemical Name:	Chlormequat (high)	
Use	0	
Formulation	0	
Application Rate	8.24	lbs a.i./acre
Half-life	35	days
Application Interval	5	days
Maximum # Apps./Year	9	
Length of Simulation	1	year
Variable application rates?	no	

Endpoints			
Avian	Japanese quail	LD50 (mg/kg-bw)	556.00
	zebra finch	LC50 (mg/kg-diet)	3175.00
	Bobwhite quail	NOAEL(mg/kg-bw)	0.00
	Bobwhite quail	NOAEC (mg/kg-diet)	390.00
Mammals	LD50 (mg/kg-bw)		487.00
	LC50 (mg/kg-diet)		0.00
	NOAEL (mg/kg-bw)		86.40
	NOAEC (mg/kg-diet)		1728.00

Dietary-based EECs (ppm)	Kenaga Values
Short Grass	12372.70
Tall Grass	5670.82
Broadleaf plants	6959.64
Fruits/pods/seeds	773.29
Arthropods	4845.97

Avian Class	Body Weight (g)	Ingestion (Fdry) (g bw/day)	Ingestion (Fwet) (g/day)	% body wgt consumed	FI (kg-diet/day)
Small	20	5	23	114	2.28E-02
Mid	100	13	65	65	6.49E-02
Large	1000	58	291	29	2.91E-01
Granivores	20	5	5	25	5.06E-03
	100	13	14	14	1.44E-02
	1000	58	65	6	6.46E-02

Avian Body Weight (g)	Adjusted LD_{50} (mg/kg-bw)
20	424.96
100	541.00
1000	764.18

Dose-based EECs (mg/kg-bw)	Avian Classes and Body Weights (grams)		
	small	mid	large
	20	100	1000
Short Grass	14091.26	8035.43	3597.57
Tall Grass	6458.49	3682.91	1648.89
Broadleaf plants	7926.33	4519.93	2023.63
Fruits/pods	880.70	502.21	224.85
Arthropods	5519.08	3147.21	1409.05
Seeds	195.71	111.60	49.97

Dose-based RQs (Dose-based EEC/adjusted LD_{50})	Avian Acute RQs Size Class (grams)		
	20	100	1000
Short Grass	33.16	14.85	4.71
Tall Grass	15.20	6.81	2.16
Broadleaf plants	18.65	8.35	2.65
Fruits/pods	2.07	0.93	0.29
Arthropods	12.99	5.82	1.84
Seeds	0.46	0.21	0.07

Dietary-based RQs (Dietary-based EEC/LC_{50} or NOAEC)	RQs	
	Acute	Chronic

Short Grass	3.90	31.72
Tall Grass	1.79	14.54
Broadleaf plants	2.19	17.85
Fruits/pods/seeds	0.24	1.98
Arthropods	1.53	12.43

Mammalian Results

Mammalian Class	Body Weight	Ingestion (Fdry) (g bwt/day)	Ingestion (Fwet) (g/day)	% body wgt consumed	FI (kg-diet/day)
Herbivores/ insectivores	15	3	14	95	1.43E-02
	35	5	23	66	2.31E-02
	1000	31	153	15	1.53E-01
Granivores	15	3	3	21	3.18E-03
	35	5	5	15	5.13E-03
	1000	31	34	3	3.40E-02

Mammalian Class	Body Weight	Adjusted LD50	Adjusted NOAEL
Herbivores/ insectivores	15	1070.34	189.89
	35	866.02	153.64
	1000	374.58	66.46
Granivores	15	1070.34	189.89
	35	866.02	153.64
	1000	374.58	66.46

Dose-Based EECs (mg/kg-bw)	Mammalian Classes and Body weight (grams)		
	15	35	1000
Short Grass	11796.42	8152.90	1890.28
Tall Grass	5406.69	3736.75	866.38
Broadleaf plants	6635.48	4586.01	1063.28
Fruits/pods	737.28	509.56	118.14
Arthropods	4620.26	3193.22	740.36
Seeds	163.84	113.23	26.25

Dose-based RQs (Dose-based EEC/LD50 or NOAEL)	Small mammal 15 grams		Medium mammal 35 grams		Large mammal 1000 grams	
	Acute	Chronic	Acute	Chronic	Acute	Chronic
Short Grass	11.02	62.12	9.41	53.06	5.05	28.44
Tall Grass	5.05	28.47	4.31	24.32	2.31	13.04
Broadleaf plants	6.20	34.94	5.30	29.85	2.84	16.00
Fruits/pods	0.69	3.88	0.59	3.32	0.32	1.78
Arthropods	4.32	24.33	3.69	20.78	1.98	11.14
Seeds	0.15	0.86	0.13	0.74	0.07	0.40

Dietary-based RQs (Dietary-based EEC/LC50 or NOAEC)	Mammal RQs	
	Acute	Chronic
Short Grass	#DIV/0!	7.16
Tall Grass	#DIV/0!	3.28
Broadleaf plants	#DIV/0!	4.03
Fruits/pods/seeds	#DIV/0!	0.45
Arthropods	#DIV/0!	2.80

Appendix D. Output of BEEREX (Version 1.0) Model for Chlormequat Chloride Exposure

Table D1. User inputs (related to exposure)

Description	Value
Application rate	8.24
Units of app rate	lb a.i./A
Application method	foliar spray
Are empirical residue data available?	no

Table D5. Results (highest RQs)

Exposure	Adults	Larvae
Acute contact	0.342277	NA
Acute dietary	2.65	1.23
Chronic dietary	4.14	44.81

Table D2. Toxicity data

Description	Value (µg a.i./bee)
Adult contact LD50	65
Adult oral LD50	100
Adult oral NOAEL	64
Larval LD50	91.2
Larval NOAEL	2.5

Table D3. Estimated concentrations in pollen and nectar

Application method	EECs (mg a.i./kg)	EECs (µg a.i./mg)
foliar spray	906.4	0.9064

soil application	NA	NA
seed treatment	NA	NA
tree trunk	NA	NA

Table D4. Daily consumption of food, pesticide dose and resulting dietary RQs for all bees

Life stage	Caste or task in hive	Average age (in days)	Jelly (mg/day)	Nectar (mg/day)	Pollen (mg/day)	Total dose (µg a.i./bee)	Acute RQ	Chron
Larval	Worker	1	1.9	0	0	0.0172216	0.00018883	0.006
		2	9.4	0	0	0.0852016	0.00093423	0.034
		3	19	0	0	0.172216	0.00188833	0.068
		4	0	60	1.8	56.01552	0.61420526	22.40
		5	0	120	3.6	112.03104	1.22841053	44.81
	Drone	6+	0	130	3.6	121.09504	1.32779649	48.43
	Queen	1	1.9	0	0	0.0172216	0.00018883	0.006
		2	9.4	0	0	0.0852016	0.00093423	0.034
		3	23	0	0	0.208472	0.00228588	0.083
		4+	141	0	0	1.278024	0.01401342	0.51
Adult	Worker (cell cleaning and capping)	0-10	0	60	6.65	60.41156	0.6041156	0.943
	Worker (brood and queen tending, nurse bees)	6 to 17	0	140	9.6	135.59744	1.3559744	2.11
	Worker (comb building, cleaning and food handling)	11 to 18	0	60	1.7	55.92488	0.5592488	0.873
	Worker (foraging for pollen)	>18	0	43.5	0.041	39.4655624	0.39465562	0.616
	Worker (foraging for nectar)	>18	0	292	0.041	264.7059624	2.64705962	4.136
	Worker (maintenance of hive in winter)	0-90	0	29	2	28.0984	0.280984	0.439

	Drone	>10	0	235	0.0002	213.0041813	2.13004181	3.32
	Queen (laying 1500 eggs/day)	Entire lifestage	525	0	0	4.7586	0.047586	0.074

Appendix E. Summary of New Environmental Fate Data

Aerobic degradation of chlormequat chloride in four soils (MRID 50747527):

The aerobic transformation of [methyl-^{14}C]-chlormequat chloride was studied in a loam soil (pH 6.6 in 1:1 soil:water), a loamy sand soil (pH 5.5 in 1:1 soil:water), and a sand soil (pH 7.8 in 1:1 soil:water) from North Dakota and a loam soil (pH 6.9 in 1:1 soil:water) from Hickman (Hanford), California that were incubated in darkness at 20 ± 2°C and soil moisture content of *ca*. pF 2.0 for up to 120 days. The soils were treated at an actual rate of 6.17 mg a.i./kg soil dry wt. for day-0 samples and at an actual rate of 5.86 mg a.i./kg soil dry wt. for day-7 to day-120 samples (equivalent to respective reviewer-calculated annual maximum field application rates of *ca*. 1544 g a.i./ha application and *ca*. 1466 g a.i./ha application assuming uniform incorporation to an appropriate depth in the field of 2.5 cm and soil density of 1.0 g/cm^3). All test systems were connected to a volatile trapping system. Duplicate samples (two entire flasks) of each treatment were collected at each sampling interval. It was not confirmed that aerobic conditions were maintained in the soils throughout the study. The soils were viable at study initiation, mid-point and termination. The study author extracted the soil using solvents with a range of dielectric constants (including non-polar solvents) including; methanol (32.6), tetrahydrofuran (7.52) and hexane (1.89).

Overall mass balance averaged 98.5 $\pm$ 3.5% (range 92.2-103%) of the applied radioactivity in the DU loam soil, 100.1 $\pm$ 2.4% (range 96.5-104%) in the loamy sand soil, 101 $\pm$ 2.4% (range 96.4-105%) in the sand soil, and 94.9 $\pm$ 3.6% (range 88.0-101%) in the Hanford loam soil. Recoveries were within guideline criteria (90-110%), except for one replicate from day 7 for the Hanford loam soil (88%).

The observed DT_{50} values, calculated half-lives, and information on transformation products are listed in **Table E1.** Chlormequat chloride dissipated with SFO DT50 values of 192 days in the DU loam soil, 283 days for the loamy sand soil, 247 days for the sand soil, and 243 days for the Hanford loam soil. No non-volatile transformation products were observed.

In the DU loam soil, extractable residues declined from 101% of the applied radioactivity at time 0 to 57.9% at 120 days, while unextracted residues increased from 2.73% at time 0 to a maximum and final of 11.4% at 120 days. Evolved $^{14}CO_2$ and other volatile organics totaled maximums and finals of 29.3% and 0.0670%, respectively, at 120 days.

In the loamy sand soil, extractable residues declined from 101% of the applied radioactivity at time 0 to 74.8% at 120 days, while unextracted residues increased from 0.900% at time 0 to a maximum and final of 9.68% at 120 days. Evolved $^{14}CO_2$ totaled a maximum and final of 16.2% at 120 days. Other volatile organics were not detected above the LOQ.

In the sand soil, extractable residues declined from 102% of the applied radioactivity at time 0 to 74.7% at 120 days, while unextracted residues increased from 1.02% at time 0 to a maximum and final of 7.69% at 120 days. Evolved $^{14}CO_2$ and other volatile organics totaled maximums and finals of 23.6% and 0.282%, respectively, at 120 days.

In the Hanford loam soil, extractable residues declined from 98.3% of the applied radioactivity at time 0 to 63.3% at 120 days, while unextracted residues increased from 2.47% at time 0 to a maximum of 14.9% at 29 days to a final of 12.5% at 120 days. Evolved $^{14}CO_2$ and other volatile organics totaled maximums and finals of 18.8% and 0.0428%, respectively, at 120 days.

Table E1. Results Synopsis: Aerobic Soil Metabolism of Chlormequat Chloride in Four Soils.

Soil Location and Texture (Temperature, pH)[1]	Observed DT_{50} (days)	Calculated Half-life (days)[2]	Model Parameters and Statistics	Transformation Products (maximum % AR, associated interval)[3]	
				Major	Minor
North Dakota Loam soil (DU) (20°C, pH 6.6)[1]	>120	DT50 = 192 (IORE)	C_0 = 99 k = 1.73E-08 S_C = 123 S_{SFO} = 224	CO_2 (29.3%, 120 days) Unextracted residues (11.4%, 120 days)	None
North Dakota Loamy sand soil (20°C, pH 5.5)[1]	>120	DT50 = 283 (SFO)	C = 98.4 k = 0.00245 S_C = 96.5 S_{SFO} = 74.1	CO_2 (16.2%, 120 days) Unextracted residues (9.7%, 120 days)	None
North Dakota Sand soil (20°C, pH 7.8)[1]	>120	DT50 = 247 (SFO)	C = 99 k = 0.00281 S_C = 128 S_{SFO} = 100	CO_2 (23.6%, 120 days)	None
California Loam soil (Hanford) (20°C, pH 6.9)[1]	>120	DT50 = 243 (SFO)	C = 84.1 k = 0.00286 S_C = 704 S_{SFO} = 640	CO_2 (18.8%, 120 days) Unextracted residues (14.9%, 29 days)	None

1 pH value for 1:1 soil:water ratio.
2 Calculated half-lives and model parameters in accordance with NAFTA kinetics guidance (USEPA, undated); best-fit values reported, Indeterminate Order Rate Equation (IORE) and Single First Order (SFO). For the loam soil from ND (DU), the reviewer opted for the IORE value of 192 as a representative half-life for that soil for use in exposure modeling, as the tIORE value of 7340 days does not reflect the DT50 for the IORE or SFO equations (and DFOP is not able to be determined based on a negative rate constant for the second phase).
3 AR means "applied radioactivity".

Aerobic aquatic degradation of chlormequat chloride in two water:sediment systems (MRID 50747528):

The aerobic transformation of [methyl-^{14}C]chlormequat chloride was studied in water:loam (Taunton River; water pH 6.7, sediment pH 5.6 and organic carbon 4.1%) and water:sand sediment systems (Weweantic River; water pH 7.3, sediment pH 5.4 and organic carbon 0.5%) from Massachusetts that were treated at an actual rate of 0.143-0.147 mg a.i./L, and incubated in the dark at 20 ± 2°C for 100 days. Duplicate samples (two entire flasks) of each test system were collected at each sampling interval. The study author extracted the soil using solvents with a range of dielectric constants (including non-polar solvents) including; methanol (32.6), tetrahydrofuran (7.52) and hexane (1.89; USEPA, 2014). Therefore, the solvents used by the study author were within the three recommended ranges.

The type of redox electrode used was not reported or if the redox potentials are standard values. Therefore, standard redox potentials, pE, and pE + pH values could not be determined.

In the water column of the Taunton River water:loam sediment system, measured redox potentials, dissolved oxygen concentration, and pH were +168.4 to +259.5 mV, 5.30-7.68 mg/L, and 4.93-6.70, respectively; measured redox potentials and pH in the sediment were +71.6 to +194.2 mV, and 4.95-6.45. The water and sediment were oxic throughout the study, however, pE+pH values could not be determined.

In the water column of the Weweantic River water:sand sediment system, measured redox potentials, dissolved oxygen concentration, and pH were +168.7 to +264.7 mV, 5.24-6.51 mg/L, and 4.22-7.30, respectively; measured redox potentials and pH in the sediment were +229.5 to +293.8 mV, and 4.20-5.72. The water and sediment were oxic throughout the study, however, pE+pH values could not be determined.

In the Taunton River water:loam sediment system, overall recoveries averaged 98.9 ± 4.1% (sample range 93.9-109.0%) of the applied. Recoveries were within guideline criteria (90-110%). In the water column, chlormequat chloride was a maximum of 99.3% of the applied at time 0, decreased to 0.647% at 100 days. In the sediment, chlormequat chloride was 14.6% at 1 day (first sampling interval), was a maximum of 51.0% at 28 days, and was 32.8% at 100 days.

In the Weweantic River water:sand sediment system, overall recoveries averaged 97.4 ± 1.6% (sample range 94.6-101.0%) of the applied. Recoveries were within guideline criteria (90-110%). In the water column, chlormequat chloride was a maximum of 99.7% of the applied at time 0, decreased to 49.1% at 100 days. In the sediment, chlormequat chloride was 12.1% at 1 day (first sampling interval), was a maximum of 37.6% at 28 days, and was 23.1% at 100 days.

Observed DT_{50} values, calculated half-lives based on the harmonized NAFTA kinetics guidance (USEPA, 2012), and information on transformation products are listed in **Table E2**. Chlormequat chloride dissipated with DFOP (Slow $t_{½}$) values of 67.9 days in the water:loam sediment system and 445 days in the water:sand sediment system. Two minor transformation products were reported (<1% of applied radioactivity) but not identified.

In the water from the Taunton River water:loam sediment system, total radioactive residues were a maximum of 99.3% of the applied at time 0 and decreased to 1.16% at 100 days. In the sediment, extractable radioactivity increased from 0.188% at time 0 to a maximum of 51.0% at 28 days and was 32.8% at 100 days. Unextracted radioactivity increased from 0.491% at time 0 to a maximum of 38.3% at 56 days and was 31.2% at 100 days. Further analysis of the unextracted residues of the 100-day chlormequat chloride sediment samples determined 14.6% fluvic acid, 3.61% humic acid, and 12.3% humin. $^{14}CO_2$ was a maximum of 41.6% of the applied at 100 days posttreatment. Volatile organics were a maximum of 2.84% at 100 days.

In the water from the Weweantic River water:sand sediment system, total radioactive residues were a maximum of 99.7% of the applied at time 0 and decreased to 41.5% at 28 days and was 49.1% at 100 days. In the sediment, extractable radioactivity increased from 0.661% at time 0 to a maximum of 37.6% at 28 days and was 23.1% at 100 days. Unextracted radioactivity increased from 1.07% at 1 day to a maximum of 20.3% at 56 days and was 17.5% at 100 days. Further analysis of the unextracted residues of the 100-day chlormequat chloride sediment samples determined 11.3% fluvic acid, 0.725% humic acid, and 5.49% humin. $^{14}CO_2$ was a maximum of 11.2% of the applied at 100 days posttreatment. Volatile organics were a maximum of 0.458% at 100 days.

Table E2. Results Synopsis: Aerobic Aquatic Metabolism of Chlormequat Chloride in the Total System[A]

Total System	Observed (d)		Kinetic Model Fitted Value[B] (d)		Representative Half-life for Modeling[B] (d)	C_0	Parameters	Transformation Products Common Name (maximum % AR, observed, associated interval)
	DT_{50}	DT_{90}	DT_{50}	DT_{90}				
Taunton River Massachusetts USA Water:loam sediment[C] (20°C, water pH 6.7, sediment pH 5.6) EOS = 100 days	28-56	>100	55	183	SFO $T_{1/2}$ = 55	89.6	k = 0.0126 S_{SFO} = 456	**Major** Unextracted residues (38.3%, 56 d) CO_2 (41.6%, 100 d) **Minor** None.
			48.8	207	**DFOP slow $T_{1/2}$ = 67.9**	98.4	k_0 = 0.425 k_1 = -0.0102 f = 0.177	
			46.2	876	$T_{R\ IORE}$ = 264	94.3	k = 1.95e-05 N = 2.59 S_C = 247	

Weweantic River, Massachusetts USA Water:sand sediment[C] (20°C, water pH 7.3, sediment pH 5.4) EOS = 100 days	>100	>100	189	627	SFO $T_{1/2}$ = 180	94	k = 0.00367 S_{SFO} = 221	**Major** Unextracted residues (20.3%, 56 d) CO_2 (11.2%, 100 d) **Minor** None.
			321	1355	**DFOP slow $T_{1/2}$ = 445**	98	k_0 = 0.0699 k_1 = -0.00156 f = 0.176	
			1399	25555 4689	$T_{R\ IORE}$ = 7.69e+07	98.3	k = 1.78e-17 N = 8.52 S_C = 51.1	

Single First Order (SFO); Double First Order in Parallel (DFOP); and Indeterminate Order Rate Equation (IORE).
d = days; AR = Applied Radioactivity; EOS = End of Study.

[A] Data were obtained from Table 9, p. 42 and Table 12, p. 45 of the study report and calculations in the attached Excel workbook (R Parent). See Attachment 3 for calculations.

[B] The kinetic model recommended to describe the persistence (shown in **bold**) is the same as that used for the development of the representative model input half-life and is consistent with the recommendations on calculating degradation kinetics (NAFTA, 2012; USEPA, 2015). The representative model input is used to develop conservative SFO model inputs but may not reflect the actual half-life observed in the study. The reviewer does not recommend a different model input or kinetic result from the standard recommendations.

[C] The Soil classification should be consistent with that recommended in *the Guidance for Determining the Acceptability of Environmental Fate Studies Conducted with Foreign Soils* (USEPA, 2011).

Anaerobic aquatic degradation of chlormequat chloride in two water:sediment systems (MRID 50747529):

The anaerobic transformation of [methyl-^{14}C]chlormequat chloride was studied in water:loam (Taunton River; water pH 6.7, sediment pH 6.5 and organic carbon 3.8%) and water:sand sediment systems (Weweantic River; water pH 6.9, sediment pH 6.6 and organic carbon 0.62%) from Massachusetts that were treated at an actual rate of 0.140 or 0.141 mg a.i./L, and incubated in the dark at 20°C for 102 days. Duplicate samples (two entire flasks) of each test system were collected at each sampling interval. The study author extracted the soil using solvents with a range of dielectric constants (including non-polar solvents) including; methanol (32.6), tetrahydrofuran (7.52) and hexane (1.89; USEPA, 2014). Therefore, the solvents used by the study author were within the three recommended ranges.

The type of redox electrode used was not reported or if the redox potentials are standard values. Therefore, standard redox potentials, pE, and pE + pH values could not be determined.

In the water column of the Taunton River water:loam sediment system, reported redox potentials, dissolved oxygen concentration, and pH were -109.6 to +9.6 mV, 0.11-0.31 mg/L, and 5.50-6.70, respectively; measured redox potentials and pH in the sediment were -188.3 to -29.0 mV, and 6.10-6.50. The water and sediment were mostly suboxic throughout the study, however, pE+pH values could not be determined.

In the water column of the Weweantic River water:sand sediment system, reported redox potentials, dissolved oxygen concentration, and pH were -180.7 to +93.9 mV, 0.10-0.37 mg/L, and 5.49-7.00, respectively; measured redox potentials and pH in the sediment were -174.3 to -53.7 mV, and 5.44-6.90. The water and sediment were mostly suboxic throughout the study, however, pE+pH values could not be determined.

In the Taunton River water:loam sediment system, overall recoveries averaged 104.5 $\pm$ 4.2% (sample range 98.2-113.0%) of the applied. Recoveries were within guideline criteria (90-110%), except for replicate A at 28 and 102 days. In the water column, chlormequat chloride was a maximum of 101% of the applied at time 0, decreased to 21.9% at 102 days. In the sediment, chlormequat chloride was 0.109% at time 0, was a maximum of 38.8% at 102 days.

In the Weweantic River water:sand sediment system, overall recoveries averaged 101.4 $\pm$ 3.2% (sample range 97.5-108.0%) of the applied. Recoveries were within guideline criteria (90-110%). In the water column, chlormequat chloride was a maximum of 101% of the applied at time 0, decreased to 32.3% at 102 days. In the sediment, chlormequat chloride was 1.14% at time 0, was a maximum of 40.4% at 102 days.

Observed DT_{50} values, calculated half-lives based on the harmonized NAFTA kinetics guidance (USEPA, 2012), and information on transformation products are listed in **Table E3**. Chlormequat chloride dissipated with calculated IORE ($t_{R\ IORE}$) values of 471 days in the water:loam sediment system and 3.71e+04 days in the water:sand sediment system. One minor transformation product was reported (<1% of applied radioactivity) but not identified.

In the water from the Taunton River water:loam sediment system, total radioactive residues were a maximum of 101.0% of the applied at time 0 and decreased to 22.6% at 102 days. In the sediment, extractable radioactivity increased from 0.258% at time 0 to a maximum of 38.8% at 102 days. Unextracted radioactivity increased from 0.795% at time 0 to a maximum of 42.9% at 102 days. Further analysis of the unextracted residues of the 102-day chlormequat chloride sediment samples determined 26.1% fluvic acid, 2.06% humic acid, and 14.6% humin. $^{14}CO_2$ was a maximum of 9.02% of the applied at 102 days posttreatment. Volatile organics were not detected above the LOD.

In the water from the Weweantic River water:sand sediment system, total radioactive residues were a maximum of 101.0% of the applied at time 0, 105 at day 1, and decreased to 32.3% at 102 days. In the sediment, extractable radioactivity increased from 1.14% at time 0 to a maximum of 40.4% at 102 days. Unextracted radioactivity increased from 0.610% at time 0 to a maximum of 26.5% at 102 days. Further analysis of the unextracted residues of the 102-day chlormequat chloride sediment samples determined 20.5% fluvic acid, 1.08% humic acid, and

4.79% humin. ${}^{14}CO_2$ was a maximum of 0.445% of the applied at 102 days posttreatment. Volatile organics were not detected above the LOD.

Table E3. Results Synopsis: Anaerobic Aquatic Metabolism of Chlormequat Chloride in the Total System[A]

Total System	Observed (d)		Kinetic Model Fitted Value [B] (d)		Representative Half-life for Modeling[B] (d)	C_0	Parameters	Transformation Products Common Name (maximum % AR, observed, associated interval)
	DT_{50}	DT_{90}	DT_{50}	DT_{90}				
Taunton River Massachusetts USA Water:loam sediment[C] (20°C, water pH 6.7, sediment pH 6.5) EOS = 102 days	>102	>102	107	356	SFO $T_{1/2}$ = 107	99.8	k = 0.00648 S_{SFO} = 260	**Major** Unextracted residues (42.9%, 102 d) **Minor** CO_2 (9.02%, 102 d)
			NA	NA	DFOP slow $T_{1/2}$ = -153	101	k_0 = 0.0118 k_1 = -0.00454 f = 0.814	
			119	1563	**T_R IORE = 471**	101	k = 2.22e-05 N = 2.31 S_C = 245	
Weweantic River, Massachusetts USA Water:sand sediment[C] (20°C, water pH 6.9, sediment pH 6.6) EOS = 102 days	>102	>102	180	599	SFO $T_{1/2}$ = 180	102	k = 0.00384 S_{SFO} = 125	**Major** Unextracted residues (26.5%, 102 d) **Minor** CO_2 (0.445%, 102 d)
			NA	NA	DFOP slow $T_{1/2}$ = -52.2	103	k_0 = 0.00721 k_1 = -0.0133 f = 0.936	
			391	123,331	**T_R IORE = 3.71e+04**	104	k = 6.19e-10 N = 4.52 S_C = 69.3	

Single First Order (SFO); Double First Order in Parallel (DFOP); and Indeterminate Order Rate Equation (IORE).
d = days; AR = Applied Radioactivity; EOS = End of Study.
[A] Data were obtained from Table 9, p. 42 and Table 12, p. 45 of the study report and calculations in the attached Excel workbook (R Parent). See
Attachment 3 for calculations.
[B] The kinetic model recommended to describe the persistence (shown in **bold**) is the same as that used for the development of the representative model input half-life and is consistent with the recommendations on calculating degradation kinetics (NAFTA, 2012; USEPA, 2015). The representative model input is used to develop conservative SFO model inputs but may not reflect the actual half-life observed in the study. The reviewer does not recommend a different model input or kinetic result from the standard recommendations.
[C] The Soil classification should be consistent with that recommended in *the Guidance for Determining the Acceptability of Environmental Fate Studies Conducted with Foreign Soils* (USEPA, 2011).

Appendix F. Summary of New Ecological Effects Data

EPA MRID 50830001 OCSPP Guideline 850.4500

In a 96-hour toxicity study, cultures of the Freshwater green alga, *Raphidocelis subcapitata* (formerly *Pseudokirchneriella subcapitata,* were exposed to chlormequat chloride technical concentrate (66.1% active ingredients; a.i) at nominal concentrations of 0 (negative control), 10, 18, 32, 56, and 100 mg ai/L under static exposure conditions. Chlormequat chloride was stable under test conditions. The mean-measured concentrations used for analysis and reporting were 0 (not detected, control), 9.81, 17.82, 31.61, 55.88, and 100.27 mg ai/L. The percent growth inhibition in cell density in the treated algal culture as compared to the control ranged from -7 to 5%. No endpoints were significantly affected in this experiment. Consequently, the NOAEC and IC_{50} for all endpoints were 100.27 and >100.27 mg ai/L, respectively. No morphological abnormalities were observed after 96 hours. The pH decreased from 8.0 but remained notably constant across all test levels and the control after 96-hours of incubation, ranging from 7.88 to 7.90. This study is scientifically sound and is classified as acceptable.

EPA MRID 51121204 OCSPP Guideline 850.1000

The 28-day chronic toxicity of chlormequat chloride technical concentrate (66.5% active ingredients; a.i.) to the mysid shrimp (*Americamysis bahia*) was studied under flow-through conditions. Mysids (<24 hours old) were exposed to nominal concentrations of 0 (negative control), 0.63, 1.3, 2.5, 5.0, and 10 mg ai/L (representing mean-measured concentrations of <0.180 (<LOD, control), 0.589, 1.20, 2.41, 4.66, and 9.26 mg ai/L, respectively). The test material was stable under the test conditions with % CVs ranging from 10 to 15%. No survival, growth, or reproductive endpoints were significantly affected by the exposure of chlormequat chloride to mysids in this study. The overall NOAEC and LOAEC were determined to be 9.26 and >9.26 mg ai/L, respectively. Production of offspring in the treated groups indicated that chlormequat chloride did not have an effect on reproduction at the concentrations tested in this experiment. This study is scientifically sound and is classified as acceptable.

EPA MRID 51121205 OCSPP Guideline 850.1400

The 35-day chronic toxicity of chlormequat chloride technical concentrate (66.5% active ingredient; a.i.) to the early life stage of the estuarine/marine Sheepshead Minnow (*Cyprinodon variegatus*; 24 hours old) was studied under flow-through conditions. Fertilized eggs/embryos (80 per level) were exposed to chlormequat chloride at nominal concentrations of 0 (negative control), 0.63, 1.3, 2.5, 5.0, and 10 mg ai/L (corresponding to mean-measured concentrations of <0.180 (<LOD, negative control), 0.547, 1.12, 2.22, 4.26, and 9.15 mg ai/L, respectively). The test system was maintained at 24.4 to 25.1 °C and a pH of 7.9 to 8.2. According to the study report, no significant effects were observed for any endpoint tested (hatching success, time to hatch, survival, and growth). The only observed sublethal effects were spinal curvature and fish on the

bottom of the test chamber, which reached a maximum of 2 affected fish in the mean-measured 1.12, 4.26, and 9.15 mg ai/L test levels. No other morphological or behavioral abnormalities were observed during the exposure. The 35-day NOAEC and LOAEC values were 9.15 and >9.15 mg ai/L, respectively. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747503 OCSPP Guideline 850.1075

In a 96-h acute toxicity study with estuarine/marine fish, sheepshead minnows (*Cyprinodon variegatus*) were exposed to chlormequat chloride technical concentrate (66.5% active ingredients; a.i.) at nominal concentrations of 0 (negative control), 6.3, 13, 25, 50, and 100 mg ai/L under static-renewal conditions. Because the test substance was stable, mean-measured concentrations of <0.200 (<LOQ, negative control), 6.6, 14, 27, 52, and 100 mg ai/L were used for analysis and reporting. As no mortality or sublethal effects were observed over the 96-hr duration of the study, the 96-h LC_{50} value is >100 mg ai/L. Based on the results of this study, technical grade chlormequat chloride would be classified as practically nontoxic to sheepshead minnows on an acute exposure basis in accordance with the classification system of the U.S. EPA. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747504 OCSPP Guideline 850.1025

In a 96-h acute toxicity study, estuarine/marine Eastern oysters (*Crassostrea virginica*) were exposed to technical grade chlormequat chloride (66.5% active ingredients; a.i.) at nominal concentrations of 0 (negative control), 6.3, 13, 25, 50, and 100 mg ai/L (representing mean-measured concentrations of <0.20 [<LOQ, negative control], 5.3, 12, 22, 54, and 100 mg ai/L) under flow through conditions. Chlormequat chloride was unstable in the lowest three test levels where the per cent of initial-measured ranged from 65 to 79%. No sublethal effects or mortalities were observed in the control or any treatment level over the 96-hr duration of the study. Shell deposition averaged 4.35 mm in the negative control, and was reduced by a maximum of 84% in the exposure groups. The effects were not clearly dose responsive. The 96-hr IC_{50} was 50 mg ai/L, based on nominal concentrations. Based on the results of this study, chlormequat chloride technical concentrate would be classified as slightly toxic to the eastern oyster, *Crassostrea virginica*, on an acute exposure basis in accordance with the classification system of the U.S. EPA. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747505 OCSPP Guideline 850.1035

In a 96-hr acute toxicity study, estuarine/marine invertebrate mysid Shrimp (*Americamysis bahia*; <24 hours old*)* were exposed to technical grade chlormequat chloride (66.5% active ingredients; a.i.) at nominal concentrations of 0 (negative control), 6.3, 13, 25, 50, and 100 mg ai/L (representing mean-measured concentrations of <0.200 [<LOQ, negative control], 6.8, 14, 26, 53, and 110 mg ai/L) under static-renewal conditions. Based on the study report, no sublethal effects were observed in the groups exposed to chlormequat chloride. Due to a maximum mortality of 10% in the groups exposed to chlormequat chloride, the 96-hr LC_{50} was estimated as >110 mg ai/L. Based on the results of this study, chlormequat chloride would be classified as practically non-toxic to *A. bahia* on an acute exposure basis in accordance with the classification system of the U.S. EPA. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747506 OCSPP Guideline 850.1400
The 32-day chronic toxicity of technical grade chlormequat chloride (66.5% active ingredient; a.i.) to the early life stage of the freshwater Fathead Minnow (*Pimephales promelas*; <24 hours old) was studied under flow-through conditions. Fertilized eggs/embryos (120 per level/<24 hours old) were exposed to chlormequat chloride at nominal concentrations of 0 (negative control), 0.63, 1.3, 2.5, 5.0, and 10 mg ai/L. The time weighted average (TWA)-measured concentrations were <0.200 (<LOQ, negative control), 0.56, 1.3, 2.4, 5.4, and 10 mg ai/L. The test system was maintained at 25 to 26 °C with a pH of 7.1 to 7.2. No significant treatment-related effects were detected for any endpoint tested (hatching success, time to hatch, survival, and growth). Sublethal effects observed in several fish at test termination included small size and spinal deformity. However, most of the surviving fish were observed to be normal at test termination. The overall 32-day NOAEC and LOAEC were 10 and >10 mg ai/L, respectively. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747507 OCSPP Guideline 850.2100
The sub-acute dietary toxicity of technical grade chlormequat chloride (66.5% active ingredient; a.i.) to young adult (21 to 29 weeks old) Zebra Finches (*Taeniopygia guttata*) was assessed over 8 days. Technical grade chlormequat chloride was administered to the birds for 5 days in the diet at nominal concentrations of 0 (negative control), 500, 1,000, 2,000, 4,000, and 8,000 mg ai/kg diet (representing reviewer-calculated mean-measured concentrations of <20.0 [<MDL, control], 489, 1004, 1871, 3872, and 6,978 mg ai/kg diet), followed by a 3-day recovery period with untreated feed. There were significant ($p<0.05$) reductions in body weight and feed consumption during the Day 0 to 5 exposure period in the 6,978 mg ai/kg diet treatment. During the post-exposure period (Days 5 to 8) body weight and food consumption in the 6,978 mg ai/kg diet treatment was significantly ($p<0.05$) increased as compared to the control. Abnormal behaviors including piloerection and/or hyperactivity were observed in chlormequat chloride-treated birds at ≥1,004 mg ai/kg diet. These behaviors increased in frequency and duration as dietary concentration increased. Gross necropsies revealed no remarkable findings. There was no mortality in the study. The 8-day dietary LC_{50} was empirically determined to be >6,978 mg ai/kg diet. Based on the results of this study, chlormequat chloride technical concentrate would be classified as practically non-toxic to young adult Zebra Finches on a sub-acute dietary exposure basis in accordance with the classification system of the U.S. EPA. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747508 OCSPP Guideline 850.2300
The one-generation reproductive toxicity of technical grade chlormequat chloride (67.8% active ingredient; a.i.) to *ca.* 16-week old Mallard Duck (*Anas platyrhynchos*) was assessed over *ca.* 24 weeks. The chlormequat chloride was administered to birds (16 pairs per level) in diet at nominal

concentrations of 0 (control), 150, 475, and 800 mg ai/kg diet (representing reviewer-calculated mean-measured concentrations of <40.0 [<MDL, control], 123, 390, and 658 mg ai/kg diet). According to the study report, no treatment-related mortalities or reproductive effects were observed in any test group. No significant effects were determined for any analyzed adult, reproductive, or offspring endpoint. Therefore, the NOAEC was empirically estimated to be 658 mg ai/kg diet, corresponding to a LOAEC of >658 mg ai/kg diet (highest treatment tested). This study is scientifically sound and is classified as acceptable.

EPA MRID 50747509 OCSPP Guideline 850.2300

The one-generation reproductive toxicity of technical grade chlormequat chloride (67.8% active ingredients; a.i) to *ca.* 18-week old Northern Bobwhite Quail (*Colinus virginianus*) was assessed over *ca.* 24 weeks. Chlormequat chloride was administered to birds (18 pairs per level) in diet at nominal dietary concentrations of 0 (control), 150, 475, and 800 mg ai/kg diet (representing reviewer-calculated mean-measured concentrations of <40.0 [<MDL, control], 123, 390, and 658 mg ai/kg diet). The ratio of 14-day hatchlings/number hatched was the only affected measurement endpoint in this study. This endpoint was significantly reduced by 5.21% relative to controls in the highest chlormequat chloride dietary treatment level of 658 mg ai/kg diet; however, this effect should be interpreted with caution because the mean and median responses appeared to be heavily influenced by a single replicate with a lower value. Further the 95% confidence intervals for the control and highest dietary treatment level are almost completely overlapping. The overall NOAEC and LOAEC are 390 and 658 mg ai/kg diet, respectively. According to the study report, no other statistically significant effects were detected for any of the adult birds or their offspring. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747510 OECD Guidance Document 213

The honey bee, *Apis mellifera* L., was exposed to CCC 750 (chlormequat chloride; 65.2% active ingredient; a.i.) for 48 hours in both acute oral and contact toxicity tests. Nominal doses for the contact test based on the formulated product were 0 (negative and solvent controls), 6.3, 12.5, 25.0, 50.0, and 100.0 µg prod/bee; corresponding to reviewer-calculated nominal doses based on the active ingredient of 4.1, 8.2, 16, 33, and 65 µg ai/bee, respectively. For the oral test, nominal actual intake doses based on the formulated product were 0 (negative control), 7.6, 14.7, 30.9, 61.6, and 123.0 µg prod/bee; corresponding to reviewer-calculated nominal actual intake doses based on the active ingredient of 5.0, 9.6, 20, 40, and 80 µg ai/bee, respectively. For both tests, active ingredient doses were used for analysis and reporting. After 48 hours of exposure in the contact test, there was 3% mortality in the 8.2 µg ai/bee treatment group. Behavioral abnormalities, specifically, moving coordination problems, were observed 4 hours after application in 3% of bees in the 8.2 µg ai/bee treatment group. After 48 hours of exposure in the oral test, there was no mortality or behavioral abnormalities observed in the negative control or groups exposed to chlormequat chloride. The LD_{50} value for the oral test was >80 µg ai/bee. The LD_{50} value for the contact test was >65 µg ai/bee. As a result, the active ingredient chlormequat chloride is categorized as practically non-toxic to adult honey bees on both acute contact and oral exposure basis. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747511 OECD Guidance Document 245

Two-day old adult honey bees, *Apis mellifera* L., was exposed to chlormequat chloride technical concentrate (66.5% active ingredients; a.i) for 10 days in a feeding study at the nominal concentrations of 8, 18, 33, 66 and 143 µg ai/bee/day representing nominal daily dietary doses of 0.26, 0.52, 1.04, 2.08 and 4.15 g ai/kg diet. Mean measured diet concentrations were 0.25, 0.49, 1.03, 2.00 and 4.02 g ai/kg diet, corresponding to measured actual intake doses of 8, 17, 33, 64 and 139 µg ai/bee/day. After 10 days of exposure, mortality was significantly affected in the highest treatment group, with a maximum effect size of 49%. Food consumption was not significantly affected in this study. The NOAEC and LC_{50} values were 2.00 and >4.02 g ai/kg diet, respectively, corresponding to NOAEL and LD_{50} values of 64 and >139 µg ai/bee/day, respectively. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747512 OECD Guidance Document 239

Less than twenty-four old individual synchronized honey bee (*Apis mellifera* – Italian hybrids) larvae (newly hatched) were exposed *in vitro* to technical grade chlormequat chloride (66.5% active ingredient; a.i.) on Day 3 (D3) through Day 6 (D6) of the study at the nominal dietary concentrations of 7.6, 23, 68, 200 and 630 µg ai/g diet, representing nominal daily dietary doses of 0.30, 0.93, 2.8, 8.3 and 25 µg ai/larva/day, respectively. Mean-measured dietary concentrations were 6.5, 21, 66, 210, 620 µg ai/g diet, corresponding to measured doses of 0.25, 0.85, 2.5, 8.3, and 25 µg ai/larva/day. Dimethoate was tested as a reference toxicant at a nominal dose of 7.4 µg ai/larva. The individual larva was considered the replicate since each larva was reared individually in a single cell. There were 36 bees (replicates) exposed per treatment group. Bees were from three or more hives. Larval mortality, pupal mortality, and bee weight were not affected in this experiment. The most sensitive endpoint was adult emergence, with NOAEC and EC_{50} values of 66 and >620 µg ai/g diet, respectively (corresponding to a NOAEL and ED_{50} of 2.5 and >25 µg ai/larva/day, respectively). Emergence exhibited a dose response, but the maximum effect was 21%. The study is scientifically sound and is consistent with the OECD Guidance Document for measuring chronic (repeat dose) toxicity to honey bee larvae. The study is classified as acceptable.

EPA MRID 50747513 OECD Guidance Document 237

Individual synchronized honey bee (*Apis mellifera* L.) larvae were exposed *in vitro* to a single dose exposure of technical grade chlormequat chloride (66.5% active ingredient; a.i.) on Day 4 of the study at the nominal dietary concentrations of 30, 97, 300, 973 and 3027 µg ai/g diet, representing nominal daily dietary doses of 1.0, 3.2, 10, 32 and 100 µg ai/larva, respectively. Mean-measured diet concentrations were 26, 89, 241, 1075 and 2761 µg ai/g diet, corresponding to measured dietary dose of 0.9, 2.9, 8.0, 35.4 and 91.2 µg ai/larva, respectively. After 72 hours, larval mortality averaged 11% in the negative control, and ranged from 11 to

17% in the treatment groups. Uneaten food was noted in both controls and all test groups, with no clear dose response. The 72-hr LC_{50} was >2761 µg ai/g diet, corresponding to a 72-hr LD_{50} of >91.2 µg ai/larva. Based on the results of this study, chlormequat chloride is classified as practically non-toxic to honey bee larvae on an acute (single dose dietary) exposure basis. The study is scientifically sound and is classified as acceptable for measuring acute (single dose) toxicity to honey bee larvae. This study is scientifically sound and is classified as acceptable.

EPA MRID 50747514 OCSPP Guideline 850.4100

The effect of the chlormequat chloride typical end-use product (TEP) Manipulator™ (56.9% active ingredient; a.i.) on the seedling emergence of monocotyledonous crops (monocot: corn, *Zea mays*; oat, *Avena sativa*; onion, *Allium cepa*; and ryegrass, *Lolium perenne)*; and dicotyledonous crops (dicot: cabbage, *Brassica oleracea*; pea, *Pisum sativum*; oilseed rape, *Brassica napus*; soybean, *Glycine max*; sugar beet, *Beta vulgaris*; sunflower, *Helianthus annuus*; and tomato, *Lycopersicon esculentum*) was studied at nominal application rates of 0 (negative control), 0.18, 0.36, 0.71, 1.4 and 2.9 lbs ai/A. Chlormequat chloride treatment rates were analytically confirmed at all treatment levels and measured rates were <0.013 (below the method detection limit; <MDL; negative control), 0.15, 0.35, 0.71, 1.2 and 2.6 lbs ai/A for cabbage, corn, oat, oilseed rape, onion, pea, ryegrass, soybean and sunflower. The measured rates for sugar beet and tomato were <0.010 (<MDL; negative control), 0.17, 0.34, 0.68, 1.3 and 2.8 lbs ai/A, respectively. The growth medium used in the seedling emergence test was a mixture of loam and sand (sand; pH 6.9 and percent organic matter 1.2% for sugar beet and tomato; pH 6.5 and percent organic matter 2.0% for all other species). On Day 14, the number of surviving plants per pot was recorded and cut at soil level for measuring the plant height and dry weight.

Negative control for emergence ranged from 80 to 100% in all species tested. No significant inhibitions in emergence were detected for any of the test species when compared to the negative control. Survival was based on the number of seeds planted. Negative control survival ranged from 80 to 100% in all species tested. No significant inhibitions in survival were detected for any of the test species when compared to the negative control. Significant ($p<0.05$) inhibitions in seedling height were detected in sugar beet, oat, and tomato. When compared to the negative control, inhibition in sugar beet height was significant at 1.4 lb ai/A and above. Inhibitions in oat and tomato height were significant at 2.9 lb ai/A, the highest treatment level. Significant ($p<0.05$) inhibition in seedling dry weight was detected in tomato. When compared to the negative control, inhibition in tomato height was significant at 2.9 lb ai/A, the highest treatment level.

The most sensitive monocot species was oat, based on reductions in plant height, with NOAEC and IC_{25} values of 1.2 and >2.6 lb ai/A, respectively. The most sensitive dicot species was sugar beet, based on reduction in plant height, with NOAEC and IC_{25} values of 0.68 and 1.7 lb ai/A, respectively. The following phytotoxic symptoms were noted: chlorosis, necrosis, and dead plants. Cabbage, corn, oat, oilseed rape, onion, pea, perennial ryegrass, soybean, sunflower, and tomato showed none to slight phytotoxic symptoms. Sugar beet showed moderate phytotoxicity with dead bean plants at the 0.36 to 1.4 lb ai/A treatment levels; however, phytotoxic effects did not show a concentration-dependent response in sugar beet.

EPA MRID 50747515 OCSPP Guideline 850.4150

The effect of the chlormequat chloride typical end-use product (TEP) Manipulator™ (56.9% active ingredient; a.i.) on the vegetative vigor of monocotyledonous crops (monocot; corn, *Zea mays*; oat, *Avena sativa*; onion, *Allium cepa*; and ryegrass, *Lolium perenne)*; and dicotyledonous crops (dicot; cabbage, *Brassica oleracea*; pea, *Pisum sativum*; oilseed rape, *Brassica napus*; soybean, *Glycine max*; sugar beet, *Beta vulgaris*; and sunflower, *Helianthus annuus*) was studied at nominal concentrations of 0 (negative control), 0.18, 0.36, 0.71, 1.4 and 2.9 lb ai/A. Chlormequat chloride treatment rates were analytically confirmed at all treatment levels and measured rates were <0.012 (negative control), 0.18, 0.38, 0.73, 1.5 and 3.0 lb ai/A, corresponding to <MDL (below the method detection limit), 103, 108, 102, 104 and 104% of the nominal concentrations, respectively. The growth medium used in the vegetative vigor test was a mixture of loam and sand (sand; pH 6.5 and percent organic matter 1.37%). On Day 21, surviving plants per pot were recorded and cut at soil level for measuring the plant height and dry weight. Seedling survival in the negative control ranged from 98 to 100% in all species tested. No significant reductions in survival were found for any of the test species when compared to the negative control. No significant effect in seedling dry weight was detected in any of the test species. Significant ($p<0.05$) reductions in seedling height were found in oat, oilseed rape and sugar beet. When compared to the negative control, reductions in oat height were significant at 0.71 lb ai/A and above. Reductions in sugar beet height were significant ($p<0.05$) at 1.4 lb ai/A only and reductions in oilseed rape height were significant ($p<0.05$) at 2.9 lbs ai/A, the highest treatment level when compared to the negative control. Based on the reviewer's results, the most sensitive monocot was oat, based on reduced height, with NOAEC and IC_{25} values of 0.38 and >3.0 lbs ai/A, respectively. The most sensitive dicot species was oilseed rape, based on reduced height, with NOAEC and IC_{25} values of 1.5 and >3.0 lbs ai/A, respectively. The following phytotoxic symptoms were noted: chlorosis, necrosis, and dead plants. All test species showed none to slight phytotoxic symptoms.