Proposed Re-evaluation Decision PRVD2022-17

Quizalofop-p-ethyl and Its Associated End-use Products

Consultation Document

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Proposed re-evaluation decision for quizalofop-p-ethyl and associated end-use products

Under the authority of the *Pest Control Products Act,* all registered pesticides must be re-evaluated by Health Canada's Pest Management Regulatory Agency (PMRA) to ensure that they continue to meet current health and environmental standards and continue to have value. The re-evaluation considers data and information from pesticide manufacturers, published scientific reports and other regulatory agencies, as well as comments received during public consultations. Health Canada applies internationally accepted risk assessment methods as well as current risk management approaches and policies.

Quizalofop-p-ethyl is a selective systemic, grass-controlling herbicide registered for postemergent control of annual and perennial grass weeds in a variety of crops such as major field crops, cucurbit vegetables, horticultural crops, forage crops for seed production and many minor specialty crops including industrial hemp grown for fibre, seed and oil. It is applied using ground or aerial equipment. Currently registered products containing quizalofop-p-ethyl can be found in the Pesticide Product Information Database and in Appendix I.

This document presents the proposed re-evaluation decision for quizalofop-p-ethyl including the proposed amendments (risk mitigation measures) to protect human health and the environment, as well as the science evaluation on which the proposed decision is based. All products containing quizalofop-p-ethyl that are registered in Canada are subject to this proposed re-evaluation decision. This document is subject to a 90-day public consultation period,[1] during which the public (including the pesticide manufacturers and stakeholders) may submit written comments and additional information to PMRA Publications. The final re-evaluation decision will be published after taking into consideration the comments and information received during the consultation period.

Proposed re-evaluation decision for quizalofop-p-ethyl

Under the authority of the *Pest Control Products Act* and based on an evaluation of available scientific information, Health Canada is proposing continued registration of all uses of quizalofop-p-ethyl and associated end-use products registered for sale and use in Canada.

With respect to human health, potential risks from dietary (food and drinking water), occupational, and non-occupational (bystander) exposure were shown to be acceptable when quizalofop-p-ethyl is used according to the proposed updated conditions of registration, which include label amendments to meet current standards such as updates to personal protective equipment for mixers, loaders and applicators, standard restricted-entry intervals, re-treatment and preharvest intervals (PHIs), and a best practice label statement to minimize the potential for spray drift.

[1] "Consultation statement" as required by subsection 28(2) of the *Pest Control Products Act*.

The environmental risk assessment found that potential risks to the environment associated with the use of quizalofop-p-ethyl were shown to be acceptable when used according to proposed conditions of registration, which includes new mitigation measures, such as precautionary statements, and spray buffer zones for the protection of terrestrial and aquatic habitats.

Quizalofop-p-ethyl has value in providing effective control of perennial grass weeds and it is the only herbicide registered for use on hemp and Ethiopian mustard.

Risk mitigation measures

Registered pesticide product labels include specific directions for use. Directions include risk mitigation measures to protect human health and the environment and must be followed by law. The proposed label amendments including any revised/updated label statements and/or mitigation measures, as a result of the re-evaluation of quizalofop-p-ethyl, are summarized below. Refer to Appendix IX for details.

Human health

Risk mitigation:

To protect workers (mixer/loader/applicator) and those entering treated areas, and bystanders the following risk-reduction measures are proposed:

- Updates to personal protective equipment (PPE) label statements as per current labeling standards.
- A standard restricted-entry interval (REI) of 12 hours is required to protect workers entering treated areas, unless a more restrictive REI is specified on the labels.

Other label updates:

- A standard drift mitigation statement is required to minimize the potential for spray drift to bystanders.

Label improvements to meet current standards:

As a result of the re-evaluation of quizalofop-p-ethyl, Health Canada is proposing additional revisions to the quizalofop-p-ethyl labels to update label statements to current policies.

A re-treatment interval of 14 days is proposed for the use on sugarbeets. Additionally, the registered uses on Oriental mustard (including canola quality brassica juncea) (condiment and oilseed type), yellow mustard, brown mustard, crambe, and chickpeas do not have specified PHIs on all current labels. New PHIs are proposed for these uses based on registrant supplied information, and are indicated in Appendix IX.

Environment

Risk mitigation:

To protect the environment, the following risk-reduction measures are proposed:

- Precautionary statements are required to inform users of the toxicity of quizalofop-p-ethyl to aquatic organisms and terrestrial plants
- Updated spray buffer zones for the protection of non-target terrestrial and aquatic habitats
- Precautionary label statement to inform users of the presence of petroleum distillates in quizalofop-p-ethyl products, and their toxicity to aquatic organisms
- Precautionary label statements regarding the potential for runoff to adjacent aquatic habitats for sites with characteristics that may be conducive to runoff and when heavy rain is forecast

Label improvements to meet current standards:

- Updated discharge of effluent statements
- Updated disposal statements
- Updated use directions and use precautions

International context

Quizalofop-p-ethyl is currently acceptable for use in other Organisation for Economic Co-operation and Development (OECD) member countries, including the United States, the European Union, and Australia. No decision by an OECD member country to prohibit all uses of quizalofop-p-ethyl for health or environmental reasons has been identified as of 9 May 2022.

Next steps

Upon publication of this proposed re-evaluation decision, the public, including the registrants and stakeholders, are encouraged to submit additional information that could be used to refine risk assessments or comments during the 90-day public consultation period.

All comments received during the 90-day public consultation period will be taken into consideration in preparation of re-evaluation decision document,[2] which could result in revised risk mitigation measures. The re-evaluation decision document will include the final re-evaluation decision, the reasons for it and a summary of comments received on the proposed re-evaluation decision with Health Canada's responses.

Refer to Appendix I for details on specific products impacted by this proposed decision.

[2] "Decision statement" as required by subsection 28(5) of the *Pest Control Products Act*.

Other information

The relevant confidential test data on which the proposed decision is based (see References Section) are available for public inspection, upon application, in Health Canada's Reading Room. For more information, please contact Health Canada's Pest Management Information Service.

Additional scientific information

No additional scientific data are required at this time.

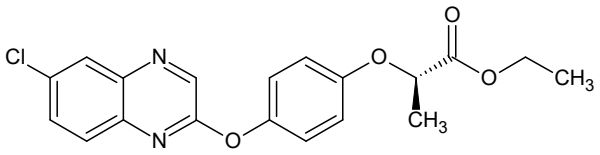
Science evaluation

1.0 Introduction

Quizalofop-p-ethyl is a selective systemic, grass-controlling herbicide registered for postemergent control of annual and perennial grass weeds in a variety of crops such as major field crops, cucurbit vegetables, horticultural crops, forage crops for seed production and many minor specialty crops including industrial hemp grown for fibre, seed and oil. Quizalofop-p-ethyl products are formulated as emulsifiable concentrate. It is typically applied once per year (except sugar beets for which two applications are allowed) using ground or aerial equipment. Currently registered products containing quizalofop-p-ethyl can be found in the Pesticide Product Information Database and in Appendix I.

2.0 Technical grade active ingredient

2.1 Identity

Common name	Quizalofop-P-ethyl
Function	Herbicide
Chemical Family	aryloxyphenoxypropioniate
Chemical name	
1 International Union of Pure and Applied Chemistry (IUPAC)	ethyl (2R)-2-{4-[(6-chloroquinoxalin-2-yl)oxy]phenoxy}propanoate
2 Chemical Abstracts Service (CAS)	ethyl (2R)-2-[4-[(6-chloro-2-quinoxalinyl)oxy]phenoxy]propanoate
CAS Registry Number	100646-51-3
Molecular Formula	$C_{19}H_{17}ClN_2O_4$
Structural Formula	
Molecular Weight	372.81

Registration number	Purity of the technical grade active ingredient
25461	98.0 %
29392	98.0 %
33269	95.7 %

Registration number	Purity of the technical grade active ingredient
33340	95.67 %
33374	98.8 %
33730	98.8 %

2.2 Physical and chemical properties

Property	Result
Vapour pressure at 20°C	1.1×10^{-7} Pa
Ultraviolet (UV) / visible spectrum	λ_{max} / ε ($M^{-1}cm^{-1}$) 209 / 2.70×10^4 234 / 3.12×10^4
Solubility in water at 20–25°C	0.61 mg/L
n-Octanol-water partition coefficient (K_{ow})	log K_{ow} = 4.61
Dissociation constant (pK_a)	No dissociable moiety between pH 4–9

3.0 Human health assessment

3.1 Toxicology summary

Quizalofop-p-ethyl belongs to the class of aryloxyphenoxypropionic herbicides that inhibit the enzyme acetyl-CoA carboxylase. Quizalofop-p-ethyl is the purified R-isomer ((+)-enantiomer) of racemic quizalofop-ethyl, the use of which was discontinued in Canada in 2001. The PMRA established in 1997 that quizalofop-p-ethyl and quizalofop-ethyl are toxicologically equivalent, and that the available quizalofop-ethyl toxicology data could be used for hazard characterization and risk assessment for quizalofop-p-ethyl. Metabolism study results (PMRA# 3130959) predominantly showed that quizalofop-ethyl (racemic) preferentially generated quizalofop-p-ethyl acid, and other metabolites, over the (-)-enantiomer metabolites, reinforcing the conclusion that data from studies conducted with the racemic form is acceptable for bridging to the hazard assessment of quizalofop-p-ethyl. Toxicological equivalency of quizalofop-p-ethyl and quizalofop-ethyl was established by comparing treatment-related findings from studies with quizalofop-p-ethyl and quizalofop-ethyl, including oral acute toxicity studies, and dietary 90-day mouse and rat toxicity studies. Additionally, noted effects were compared, at the time of setting the toxicity equivalence, to data from a 6-month dog toxicity study and a 2-generation rat reproductive toxicity study; both of these studies were conducted with racemic quizalofop-ethyl.

A detailed review of the combined toxicological database for quizalofop-ethyl and quizalofop-p-ethyl was conducted. The combined database is complete, consisting of the full array of toxicity studies currently required for hazard assessment purposes. The studies were carried out in accordance with accepted international testing protocols and Good Laboratory Practices at the time of conduct. The following studies in the database were conducted with quizalofop-p-ethyl: an acute oral toxicity study in rats, a 13-week oral toxicity study (dietary) with 4-week recovery

period in mice, a 13-week oral toxicity study (dietary) in rats, a bacterial reverse mutation assay (in vitro), an unscheduled DNA synthesis study in rat hepatocyte cells, a mouse lymphoma forward mutation assay and a 28-day oral immunotoxicity study (enzyme-linked immunosorbent assay) (dietary) in CD-1 mice. A number of supplementary liver enzyme studies were also submitted. Several newly submitted studies were also reviewed, including acute toxicity studies, an immunotoxicity study, a short-term dermal toxicity study, and an addendum to the absorption, distribution, metabolism, and excretion study that focused on metabolite characterization. In addition, relevant information found in the published scientific literature was considered. The scientific quality of the data is acceptable and the database is considered adequate to characterize the potential health hazards associated with quizalofop-p-ethyl.

The metabolism of quizalofop-ethyl in rats was investigated using ^{14}C-labelling at either the phenyl or quinoxaline ring, to improve characterization of metabolites. Animals were dosed by gavage with single low-, single high- or repeated low-doses of radiolabelled quizalofop-ethyl. Radiolabelled quizalofop-ethyl was rapidly absorbed and extensively metabolised following oral administration, regardless of the dosing regimen. Maximal plasma and tissue concentrations were achieved within 6 to 9 hours of a single low- or high-dose administration; except for adipose and adrenal tissues where concentration peaked after a high-dose, at 24 and 3 hours, respectively. Although there were minor differences due to dosing regimen and sex, the highest residual tissue radioactivity levels after seven days were found in the blood, gastrointestinal (GI) tract, skin, fur, liver, thyroid and kidneys. Tissue retention of radiolabel was low after seven days, regardless of the dosing regimen.

Quizalofop-ethyl was rapidly degraded to quizalofop-acid after oral administration, followed by cleavage of the quinoxaline-phenyl ether bond and β-glucuronide conjugation to produce additional metabolites. The radiolabel position had no impact on metabolism or excretion, with only small variations noted. The primary isolated urinary metabolites included quizalofop-acid, 2-(4-hydroxyphenoxy) propionic acid (PPA), dechlorinated hydroxylated analogs of quizalofop-acid: HO1-quizalofop-acid and HO2-quizalofop-acid, the hydroxylated analog of quizalofop-ethyl, quizalofop-phenol, and quizalofop-acetate. Fecal metabolites were similar to those found in urine. Approximately a quarter of the administrated dose (AD) was excreted in the bile within 24 hours, increasing to approximately half of the AD within 48 hours, following a low dose. A slightly smaller portion of the AD was excreted in the bile within 24 hours of a single high dose. The elimination half-life was 32 to 36 hours in most tissues, with the exception of white adipose tissue (155 hours) and brown adipose tissue (61 hours) following a single high dose. The overall excretion was rapid with half-lives of 48–60 hours following a single low dose and 48–85 hours following a single high dose. The elimination half-lives were approximately 46 and 42 hours for a repeated low-dose regimen, in males and females, respectively. The concentrations of radioactivity in each tissue, including the fat, reached maximum levels after seven consecutive daily oral administrations, and decreased after additional low-dose administrations up until study termination at 28 days.

In each tissue, except fat, the rate of elimination was similar after 7, 14 or 28 days of dosing. At 120 hours post-final dose, only trace radioactivity was noted in intestines, blood, liver, fur and fat in the whole body autoradiograms, indicating the lack of significant accumulation following repeated administration.

The level of radioactivity detected in excreta (urine and feces combined) was similar in males and females after a single or repeated low dose. However, there were sex differences in the relative amount of radioactivity excreted via urine or feces. In males, there was 2 to 4.5-fold more radiolabel detected in feces than in urine. Following a single high dose, females excreted a higher proportion of radiolabel in their feces than males. The proportion of fecal elimination in males was similar following either a single low or single high dose.

In a published study (PMRA# 3130959), authors studied enantioselective metabolism of a single low dose of racemic quizalofop-ethyl in male Sprague-Dawley rats (gavage and intravenous routes), and confirmed that metabolism of racemic quizalofop-ethyl to racemic quizalofop-acid was rapid in vivo, but further metabolism of quizalofop-acid was slower. Both enantiomers of quizalofop-acid had similar calculated oral bioavailability (73% and 84%, for (+)- and (-)-enantiomer, respectively). The concentration-time area under the curve (in blood, after gavage administration) was approximately 6.6-fold greater for quizalofop-p-acid ((+)-enantiomer) than the (-)-enantiomer. Quizalofop-p-acid ((+)-enantiomer) represented a higher proportion of tissue residues (in brain, kidney, lung and liver) than the (-)-enantiomer. The authors suggested that selective uptake, and elimination of enantiomers may be responsible for the enrichment of quizalofop-p-acid in tissues.

In acute oral toxicity studies in rats, quizalofop-p-ethyl, the (+)-enantiomer, was of slight acute toxicity, whereas the (-)-enantiomer was of moderate acute toxicity. Racemic quizalofop-ethyl was of low to slight acute oral toxicity, low acute dermal toxicity in rabbits and low acute inhalation toxicity in rats. Based on studies with quizalofop-ethyl, quizalofop-p-ethyl was considered to be minimally irritating to the rabbit eye, non-irritating to the rabbit skin and was not a dermal sensitizer in guinea pigs following testing by the Buehler method. Clinical signs following acute oral administration of racemic mix or separate enantiomers in rats included slower gait and ruffled fur, wet inguinal fur and redness around the eyes, and additionally tremors and hunched posture were noted with quizalofop-p-ethyl treatment.

Following short- and long-term repeated dietary exposure, the main target organ was the liver in mice, rats and dogs. In addition, mild anemia and testicular changes were observed in rats and mice. Liver effects included increased organ size and weight, changed colour, and increased serum enzyme levels (alkaline phosphatase, alanine aminotransferase, and aspartate aminotransferase). Liver histopathological changes included hypertrophy and hyperplasia, degeneration and necrosis of individual hepatocytes, and, in mice and rats, bile duct hyperplasia. Liver degeneration and/or necrosis was still observed at the high-dose level in male mice following 4 weeks of recovery in a 13-week dietary toxicity study, but liver hypertrophy and/or hyperplasia was reversible in both sexes of mice. Testicular changes noted in some toxicity studies in rats and mice included decreased testes weight, flaccid or atrophied testes, and/or suppression of spermatogenesis and atrophy of seminiferous tubules. The testicular effects were not reversible in rats following a 6-week recovery period. The testicular atrophy observed in the 13-week toxicity study in dogs was not replicated in a longer-term 12-month toxicity study; however these observed reductions in testicular and epididymal weights are noteworthy, as similar changes occurred in the rat, mouse and the dog. Blood clinical chemistry effects in rodents included increased levels of total protein, urea nitrogen, calcium, and serum albumin, and decreased cholesterol. Increased platelet counts were noted, as well as increased extramedullary hematopoiesis in the spleen, which was interpreted as regenerative hemolytic

anemia. Thyroid weights were increased in the chronic dietary toxicity study in rats. In mice, increased adrenal weights with notable cortical cell hypertrophy, increased thyroid weight with follicular hyperplasia, as well as increased kidney weight with granular, pitted or rough kidneys, and kidney cysts were noted in an 18-month dietary oncogenicity study. Additionally, a swollen abdomen and increased ovarian weight were noted following chronic treatment in mice.

Racemic quizalofop-ethyl did not cause any treatment-related pathological effects in rabbits in a supplemental 21-day dermal toxicity study with a two-week recovery period; however, limited parameters were examined in this study.

A standard genotoxicity battery was available, consisting of bacterial gene mutation studies with quizalofop-ethyl and quizalofop-p-ethyl, a chromosome aberration study with quizalofop-ethyl, and mammalian gene mutation assessed with quizalofop-p-ethyl in vitro, as well as an in vivo micronucleus study with quizalofop-ethyl and unscheduled DNA synthesis assays with quizalofop-ethyl and quizalofop-p-ethyl. Results from these studies indicated that quizalofop-p-ethyl was not genotoxic.

In an 18-month dietary oncogenicity study in mice with racemic quizalofop-ethyl, a single incidence of granulosa cell tumour and a slightly increased incidence of benign ovarian luteomas at the high dose level was not considered to be treatment-related since the incidence only marginally exceeded the historical control range. In addition, the lack of statistical significance to concurrent controls, no ovarian hyperplasia, lack of progression to malignancy, no clear dose-response, and no altered endocrine activity related to ovarian function, do not support a finding of treatment-related tumourigenicity. Two instances of luteal cell hyperplasia were also noted at the high dose-level, but these were not statistically significant (historical control was unavailable). There was an increased incidence of ovarian cysts noted at the high-dose level at the interim sacrifice (57 weeks), but in the absence of statistical significance and dose response at the terminal sacrifice, the effect was not considered treatment-related.

There were increased incidences of hepatocellular adenomas and carcinomas in the males at the high-dose level of the same 18-month oncogenicity study in mice. The increased incidence of hepatocellular adenomas and carcinomas in the high-dose males was within their respective historical control ranges. The incidence of liver tumours in male mice at the high-dose level exceeded the historical control range for hepatocellular adenomas and carcinomas defined by another, smaller set of historical control studies. The incidence of male liver adenomas in the concurrent controls of the study was at the upper end of the range from that less robust historical control data set. There were no statistically significant pairwise differences between dose groups with respect to tumour incidence, but the combined incidence of hepatocellular adenomas and carcinomas was statistically significantly increased at the high-dose level, when compared to concurrent controls. Treatment had no effect on the multiplicity or tumour latency. There were no treatment-related hepatocellular tumours in female mice. The highest dose level approached the maximum tolerated dose given that decreased survival of males was observed at week 78. Overall, the weight of evidence indicated a low level of concern for these tumours in mice.

In a 24-month dietary chronic toxicity/carcinogenicity study in rats with racemic quizalofop-ethyl, a slightly increased incidence of hepatocellular carcinomas in females at the high-dose level was not considered treatment-related since it was not statistically significant. The incidence

was slightly higher than the historical control range, but no dose-response was observed with the combined incidence of liver adenomas and carcinomas. There were no treatment-related tumours in male rats.

Non-guideline liver enzyme studies indicated that quizalofop-ethyl is not an inducer of cytochrome P450 in rats and mice. Quizalofop-ethyl was regarded as a weak or a mild inducer of cytochrome b5 in only one study in mice.

In a 2-generation dietary reproductive toxicity study in rats with racemic quizalofop-ethyl, evidence for reproductive toxicity occurred only at the highest dose level tested and consisted of decreased F1 pup weight at birth, in the presence of parental toxicity. Sperm parameters were not measured, although these parameters were not required at the time of study conduct. Testicular effects noted in the 13-week rat study (decreased testes weight, small and flaccid testes, testicular atrophy and/or suppression of spermatogenesis) were not reversible following a 6-week recovery period. Decreased F2b testes weights were noted in the reproductive toxicity study in rats; however no adverse effects were noted on the reproductive performance in the 2-generation reproductive toxicity study or in the reproductive cohort from the modified developmental study in rats. Reproductive indices were not affected. Sensitivity of the young was observed as body weight and liver effects in the mid- and high-dose level, respectively, starting on postnatal day (PND) 21 in the absence of parental toxicity. Liver effects noted in offspring were increased liver weight and, at higher dose levels, liver histopathology (increased eosinophilic granular cytoplasm of hepatocytes, decreased cytoplasmic basophilia and glycogen accumulation). These liver effects were not considered adverse at the low-dose level, but progressed in incidence and severity of lesion at the mid- and high-dose levels (focal). During the third week of life, pups likely had increased exposure to quizalofop-p-ethyl due to consumption of both milk and treated feed, leading to treatment-related effects on PND 21. At the highest dose level tested, the following were observed: decreased pup body weight on PND 0-21 in the F1 generation and on PND 7-21 in the F2 generations, as well as decreased spleen, thymus, lung and testes weights and increased relative heart weight in the F2 generation, in the presence of parental toxicity. The parental treatment-related effects at the highest dose level included decreased body weights in males and decreased body-weight gains in both sexes.

In a modified gavage developmental toxicity study in rats with racemic quizalofop-ethyl, two sets of animals were used per treatment group. One group was sacrificed on gestational day (GD) 21, and a smaller group was retained as a nursing group set, with 2/sex from each litter retained to study the reproductive ability at 10 weeks (the remaining of nursing subgroup sacrificed at 8 weeks). In this study, minor foetal skeletal variations were noted in the presence of maternal toxicity at the highest dose level tested. These variations included increased incidences of accelerated ossification of the corpus of the cervical vertebrae and of diaphysis of metatarsus (1st digit), delayed ossification in the arcus of the 3rd coccygeal vertebra and of the phalanges proximales, and increased incidence of small 14th rib. In birthed pups that continued to nurse/feed until 8 weeks post-birth, no treatment-related skeletal variations were noted. There was no indication of treatment-related changes in learning or behaviour in performed functional tests (3–4 weeks post-birth) or in a learning test (swim maze at 5 weeks post-birth); however it should be noted that these animals were not treated post-organogenesis (treatment occurred on GD 5-16). Decreased body weight was noted in the high-dose offspring on PND 4, and at 5–8 weeks, with food consumption transiently decreased at 4–8 weeks. There were no treatment-

related effects on reproductive indices noted in rats in the reproductive subgroup in this modified developmental toxicity study in rats. Preputial separation was not measured, but vaginal patency was not affected by treatment. No treatment-related malformations were noted in rat fetuses or pups. In dams, the observed effects were limited to decreased body-weight gain and food consumption and an increased incidence of retained placentas, which were interpreted as late resorptions, in the absence of further information.

No maternal or developmental treatment-related effects were noted up to the high-dose level in two rabbit gavage developmental toxicity studies. In a dose range-finding study in rabbits, body-weight loss and decreased body-weight gain were noted starting at the low dose-level, in addition to an increased incidence of abortions starting at the mid-dose level; however, these effects were not observed in the two main studies at a comparable dose level (high dose level). There was no evidence of sensitivity of the young or treatment-related malformations in rabbits.

The weight of evidence suggests that quizalofop-p-ethyl does not have potential to cause selective neurotoxicity.

The immunization response was not affected by the treatment with quizalofop-p-ethyl. There were no compound related effects on mortality, clinical signs, body weight, food consumption, organ weights, including spleen, gross pathology, histopathology or elevated immunoglobin counts in mice with quizalofop-p-ethyl treatment. However, some liver effects were noted at the high dose. Quizalofop-p-ethyl was not considered immunotoxic to mice.

Toxicology reference values for human health risk assessment are summarized in Appendix III, Table 1, and select metabolites are identified in Appendix III, Table 2. The results of toxicology studies conducted in laboratory animals with quizalofop-ethyl and quizalofop-p-ethyl are summarized in Appendix III, Table 3.

3.1.1 *Pest Control Products Act* hazard characterization

For assessing risks from potential residues in food or from products used in or around homes orschools, the *Pest Control Products Act* requires the application of an additional 10-fold factor to threshold effects to take into account completeness of the data with respect to the exposure of, and toxicity to, infants and children, and potential prenatal and postnatal toxicity. A different factor may be determined to be appropriate on the basis of reliable scientific data.

With respect to the completeness of the toxicity database, as it pertains to the toxicity to infants and children, the database contains the standard complement of required studies including a developmental toxicity study in rabbits, a modified developmental toxicity study in rats, and a multi-generation reproductive toxicity study in rats. An additional developmental toxicity study in rabbits and a supplemental developmental toxicity dose-range finding study in rabbits were also available.

With respect to potential prenatal and postnatal toxicity, sensitivity of the young was observed in the dietary 2-generation reproductive toxicity study in rats, but the level of concern for the observed effects is low. Liver effects in the young at the end of the lactation period, including increased liver weight and changes in histopathology, occurred at a dose level that did not cause

toxicity to the maternal animals. However, these liver effects were not considered adverse at the low-dose level. Decreased pup body weights in both generations, and some changes to organ weights in F2 generation pups were observed at the high-dose level, but the concern for these findings was tempered by the presence of parental toxicity. The pups were likely exposed to a higher dose than the maternal animals due to their consumption of both milk and treated feed in the last week pre-weaning. As a result, the amount of quizalofop-p-ethyl being consumed by the pups on a per kg/bw basis is assumed to be underestimated in comparison to the maternal dose level. Absolute testes weights were decreased in the F2 males at the high-dose level, where a decrease in offspring body weight also occurred. Sperm parameters were not measured in this study. Although some testicular changes were noted in the repeat-dose studies in rats and mice in the database, these effects were noted at a higher dose level in rats, and at a comparable dose level in mice following long-term treatment. Additionally, since there were no treatment-related changes to the reproductive indices, the residual concern for the lack of sperm parameter data is diminished. Reproductive toxicity occurred only at the highest dose tested and consisted of decreased F1 pup birth weights, with concern tempered by the presence of parental toxicity.

In a modified rat gavage developmental toxicity study, minor treatment-related skeletal variations noted in fetuses in the presence of maternal toxicity were not observed at 8 weeks post-birth. No treatment-related malformations were noted. In dams, the observed systemic toxicity was limited to decreased body-weight gain and food consumption and increased incidence of retained placenta (interpreted as late resorptions) at the high dose level. Some of the reserved pups in the nursing group were examined for neurotoxicity with no indication of treatment-related changes to learning or behaviour in functional tests 3–4 weeks post-birth, or in a learning test (swim maze 5 weeks post-birth). However these animals were not treated post-organogenesis (only on GD 6-15). Continual neuronal development in rats post GD 15 is expected according to predicted timing of neural events (PMRA# 3130950). Decreased body weight and food consumption were noted in high-dose level offspring.

In two rabbit gavage developmental toxicity studies, no maternal or developmental treatment-related effects were noted up to the highest dose tested. In a dose range-finding study in rabbits, an increased incidence of abortions, body-weight loss and decreased body-weight gain were noted, however these effects were not observed in the two main studies conducted at slightly lower dose levels. There was no evidence of sensitivity of the young or treatment-related malformations in rabbits.

Overall, the database is adequate for determining the sensitivity of the young and effects on the young are well-characterized. There is a low concern for sensitivity of the young. The noted serious effect of increased incidence of abortions in the supplementary dose-range finding study in rabbits is of low concern since abortion was not observed in the two main developmental toxicity studies in the rabbits at a slightly lower high dose level. The concern for the increased incidence of retained placenta in rats in the modified developmental toxicity study, interpreted as late resorptions, was tempered by the presence of parental toxicity. On the basis of this information, the *Pest Control Products Act* factor (PCPA factor) would be reduced to threefold if this endpoint was used for the point of departure for risk assessment. However, the toxicological reference values selected for risk assessment provide an intrinsic margin to the endpoint of the increased late resorptions in rats, and abortions in rabbits. Consequently, the PCPA factor was reduced to onefold.

3.2 Dietary exposure and risk assessment

In a dietary exposure assessment, Health Canada determines how much of a pesticide residue, including residues in milk and meat, may be ingested with the daily diet. Exposure to quizalofop-p-ethyl from potentially treated imports is also included in the assessment. These dietary assessments are age-specific and incorporate the different eating habits of the population at various stages of life (infants, children, adolescents, adults and seniors). For example, the assessments take into account differences in children's eating patterns, such as food preferences and the greater consumption of food relative to their body weight when compared to adults. Dietary risk is then determined by the combination of the exposure and the toxicity assessments. High toxicity may not indicate high risk if the exposure is low. Similarly, there may be risk from a pesticide with low toxicity if the exposure is high.

Health Canada considers limiting use of a pesticide when risk exceeds 100% of the reference dose. Health Canada's Science Policy Note SPN2003-03, *Assessing Exposure from Pesticides, A User's Guide*, presents detailed risk assessment procedures.

Residue estimates used in the dietary exposure assessment (DEA) may be based conservatively on the maximum residue limits (MRL) or the field trial data representing the residues that may remain on food after treatment at the maximum label rate. Surveillance data representative of the national food supply may also be used to derive a more accurate estimate of residues that may remain on food when it is purchased. These include the Canadian Food Inspection Agency's (CFIA) National Chemical Residue Monitoring Program and the United States Department of Agriculture Pesticide Data Program (USDA PDP). Specific and empirical processing factors as well as specific information regarding percent of crops treated may also be incorporated to the greatest extent possible.

Sufficient information was available to adequately assess the dietary risk from exposure to quizalofop-p-ethyl. Chronic dietary exposure and risk assessments were conducted using the Dietary Exposure Evaluation Model - Food Commodity Intake Database™ (DEEM–FCID™, Version 4.02, 05-10-c) program, which incorporates food consumption data from the National Health and Nutrition Examination Survey/What We Eat in America (NHANES/WWEIA) for the years 2005-2010 available through the Centers for Disease Control and Prevention's (CDC) National Center for Health Statistics (NCHS). Further details on the consumption data are available in Health Canada's Science Policy Note SPN2014-01, *General Exposure Factor Inputs for Dietary, Occupational and Residential Exposure Assessments*. For more information on the dietary risk estimates or the residue chemistry information used in the dietary assessment, see Appendix IV and Appendix V.

The basic chronic dietary exposure estimates for quizalofop-p-ethyl were conducted using Canadian MRL/American tolerance level residues, and default processing factors as appropriate.

3.2.1 Determination of acute reference dose (ARfD)

Establishment of an acute reference dose is not required, as an endpoint of concern attributable to a single exposure was not identified in the oral toxicity studies.

3.2.2 Determination of acceptable daily intake (ADI)

To estimate risk from repeated dietary exposure, a NOAEL of 0.9 mg/kg bw/day from the 24-month dietary chronic toxicity/carcinogenicity study in rats was selected. At the LOAEL of 3.7/4.6 mg/kg bw/day (males/females), liver histopathology and mild anemia were observed. Standard uncertainty factors of 10-fold for interspecies extrapolation and 10-fold for intraspecies variability were applied. As discussed in the *Pest Control Products Act* hazard characterization Section, the PCPA factor was reduced to onefold. The composite assessment factor (CAF) is thus 100.

The ADI is calculated according to the following formula:

$$\text{ADI} = \frac{\text{NOAEL}}{\text{CAF}} = \frac{0.9 \text{ mg/kg bw/day}}{100} = 0.01 \text{ mg/kg bw/day of quizalofop-p-ethyl}$$

The ADI provides a margin of 260 to the offspring NOAEL of 2.6 mg/kg bw/day for the liver and body weight effects in the 2-generation reproductive toxicity study in rats, a margin of 10 000 to the NOAEL of 100 mg/kg bw/day for the increased incidence of retained placenta (late resorptions) in the modified developmental toxicity study in rats, a margin of 800 to the NOAEL of 8 mg/kg bw/day for the testicular effects noted in 13-week dietary toxicity study in rats, and a margin of 150 to the NOAEL of 1.5 mg/kg bw/day for the testicular effects noted in 18-month dietary oncogenicity study in mice.

3.2.3 Chronic dietary exposure and risk assessment

The basic chronic dietary risk from food and drinking water was calculated using the average consumption of different foods and water, and the average residue values on those foods and water. The estimated exposure to quizalofop-p-ethyl and its metabolites was then compared to the ADI. When the estimated exposure is less than the ADI, the chronic dietary exposure is acceptable.

The chronic assessment was conducted using Canadian MRL/American tolerance level residues, and default processing factors as appropriate. Drinking water contribution to the exposure was accounted for by direct incorporation of the chronic estimated environmental concentration (EEC) value obtained from modelling (see Section 3.3) into DEEM. The chronic dietary (food and drinking water) exposure estimates were less than the ADI for the general population and all subpopulations (< 53% of the ADI). On this basis, a dietary exposure from food and drinking water, is considered acceptable under current conditions of use.

The dietary risk estimates are presented in Appendix IV.

3.2.4 Cancer assessment

Quizalofop-p-ethyl was not considered to be genotoxic in a battery of in vitro and in vivo genotoxicity assays.

In an 18-month dietary oncogenicity study in mice, an increased incidence of benign ovarian luteomas was not considered treatment-related since the incidence only marginally exceeded the historical control range, and there was no statistical significance, no pre-neoplastic lesions, no progression to malignancy, no clear dose-response, and no altered endocrine activity related to ovarian function. The increased incidences of hepatocellular adenomas and carcinomas in the males at the high-dose level, which approached the maximum tolerated dose in mice, was within the historical control range of a more robust historical control data set. Even though the combined incidence of hepatocellular adenomas and carcinomas was statistically significantly increased at the high-dose level compared to concurrent controls, there were no statistically significant pairwise differences with respect to adenoma or carcinoma incidence, treatment did not affect multiplicity or latency, and there were no treatment-related hepatocellular tumours in female mice. Overall, the weight of evidence indicated a low level of concern for these tumours in mice. Therefore, a threshold-based cancer risk assessment approach was considered appropriate for the liver tumours in male mice.

In a two-year dietary carcinogenicity/toxicity study in rats, a slightly increased incidence of hepatocellular carcinomas in females at the high-dose level was not considered treatment-related since it was not statistically significant, was within the historical control range, and no dose-response was observed. There were no treatment-related tumours in male rats. Overall, the weight of evidence indicated no evidence of oncogenicity in rats.

3.3 Exposure from drinking water

Residues of quizalofop-p-ethyl, quizalofop-p, hydroxy-quizalofop, dihydroxy-quinoxaline, and hydroxy-quinoxaline in potential drinking water sources were estimated from water modelling.

3.3.1 Concentrations in drinking water

Estimated environmental concentrations (EECs) for the combined residue of quizalofop-p-ethyl and its major transformation products quizalofop-p, hydroxy-quizalofop-p, hydroxy-quinoxaline and dihydroxy-quinoxaline in potential drinking water sources (groundwater and surface water) were generated using computer simulation model Pesticide in Water Calculator (PWC) Version 1.52. Modelling for surface water used a standard Level 1 scenario, a small reservoir adjacent to an agricultural field. EECs in groundwater were calculated by selecting the highest EEC from a set of standard scenarios representing different regions of Canada. Both the surface water and groundwater scenarios were run for 50 years.

Level 1 EECs are conservative values that are calculated using conservative inputs with respect to application rate, application timing, and geographic scenario. Level 1 EECs cover all regions of Canada. Modelling used initial application dates between May and July. The highest yearly EEC (5.6 µg/L) was used for the chronic assessment.

Table 3.3.1 Level 1 Estimated environmental concentrations (EECs) of quizalofop-p-ethyl in drinking water

Crop and annual application rate	Active Ingredient (RD in water)	Groundwater (µg a.i./L)		Surface Water (µg a.i./L)	
				Reservoir	
		Acute[1]	Chronic[2]	Acute[3]	Chronic[4]
Canola, pumpkin, soybeans and peas 72 g a.i./ha; 1 application/season	quizalofop-p-ethyl + quizalofop-p + hydroxy-quizalofop-p + dihydroxy-quinoxaline + hydroxy-quinoxaline	5.6	**5.6**	2.7	0.80

1 90th percentile of daily average concentrations.
2 90th percentile of 365-day moving average concentrations.
3 90th percentile of peak concentrations from each year.
4 90th percentile of yearly average concentrations.

3.3.2 Drinking water exposure and risk assessment

Drinking water exposure estimates were combined with food exposure estimates, with EEC values incorporated directly in the chronic dietary (food and drinking water) assessments. Please refer to Section 3.2.4 for details and conclusions.

3.4 Occupational and non-occupational exposure and risk assessment

There is potential for occupational exposure to quizalofop-p-ethyl during mixing, loading, and/or applying the pesticide, and when entering a treated site to conduct postapplication activities, such as irrigation or scouting. There is a potential for non-occupational (bystander) exposure to quizalofop-p-ethyl residues from spray drift during commercial applications.

3.4.1 Toxicological reference values

Toxicology reference values used in the assessment are summarized in Appendix III.

3.4.1.1 Short-term dermal

For short-term occupational exposure via the dermal route, the offspring NOAEL of 2.6 mg/kg bw/day from the 2-generation dietary reproductive toxicity study in rats was selected for risk assessment, based on liver effects, and organ weight changes in offspring observed in the absence of maternal toxicity. The existing short-term dermal toxicity study in the rabbit was considered supplemental because it lacked information on such parameters as clinical signs, body weight, food consumption, hematology, clinical chemistry and organ weights. Further, the dermal study did not assess the endpoint of concern, namely body weight and liver effects in offspring following prenatal or post-natal exposure, thus necessitating the use of an oral toxicity

study to define the point of departure. Worker populations could include pregnant or lactating women and therefore these endpoints were considered appropriate for the occupational risk assessment. The target margin of exposure (MOE) is 100 and includes uncertainty factors of 10-fold for interspecies extrapolation and 10-fold for intraspecies variability. The selection of this study and target MOE is considered to be protective of all populations, including nursing infants and the unborn children of exposed female workers.

3.4.1.2 Short-term inhalation

For short-term occupational exposure via the inhalation route, a repeat-dose inhalation toxicity study was not available. In the absence of such a study, the offspring NOAEL of 2.6 mg/kg bw/day from the 2-generation dietary reproductive toxicity study in rats was selected for risk assessment. This was based on liver effects and organ weight changes noted in offspring in the absence of maternal toxicity. The target MOE is 100, which includes uncertainty factors of 10-fold for interspecies extrapolation and 10-fold for intraspecies variability. The selection of this study and target MOE is considered to be protective of all populations, including nursing infants and the unborn children of exposed female workers.

3.4.2 Dermal absorption factor

Based on the available information, it was determined that a dermal absorption factor (DAF) of 50% was considered appropriate for use in the risk assessment for quizalofop-p-ethyl, and is not expected to underestimate exposure.

3.4.3 Non-occupational exposure and risk assessment

Non-occupational (residential) risk assessment involves estimating risks to the general population, including the risks to youth and children, during or after pesticide application by the users. Domestic-class products containing quizalofop-p-ethyl are not registered in Canada; therefore, residential handler exposure is not anticipated. Commercial-class products containing this active ingredient are not expected to be used in residential settings. There is, however, a potential for non-occupational (bystander) exposure to quizalofop-p-ethyl residues from spray drift during agricultural applications.

The potential for bystander exposure is expected to be minimal and the risk is considered to be acceptable under current conditions of use. A standard label statement to minimize a spray drift potential is proposed to be included on labels of all end-use products containing quizalofop-p-ethyl.

The proposed label amendments are listed in Appendix IX.

3.4.4 Occupational exposure and risk assessment

Occupational risk is estimated by comparing potential exposures with the most relevant endpoint from toxicology studies to calculate a margin of exposure (MOE). This is compared to a target MOE incorporating uncertainty factors protective of the most sensitive subpopulation. If the calculated MOE is less than the target MOE, it does not necessarily mean that exposure will result in adverse effects, but mitigation measures to reduce risk would be required.

3.4.4.1 Mixer, loader, and applicator exposure and risk assessment

Based on the currently registered use pattern, potential exposure of mixers/loaders/applicators is expected to occur via dermal and inhalation routes and to be of a short-term duration.

The following exposure scenarios were assessed based on the currently registered use pattern:

1) Open mixing/loading of liquid formulation and application as a spray using open cab groundboom equipment
2) Open mixing/loading of liquid formulation for aerial applications
3) Aerial application

In the absence of chemical-specific data for quizalofop-p-ethyl, exposure of mixer/loader/ applicator (M/L/A) was assessed using exposure data from the Agricultural Handlers Exposure Task Force (AHETF) for an open cab groundboom or aerial application equipment scenario. Workers are assumed to wear personal protective equipment including coveralls plus chemical-resistant gloves. Additional assumptions included default area treated per day (ATPD) values, the maximum registered application rates, and an average worker body weight of 80 kg. Dermal exposure was adjusted for 50% dermal absorption.

The risk assessment for mixers/loaders/applicators are presented in Appendix VI. For all assessed scenarios, the estimated combined (dermal plus inhalation) MOEs are greater than the target MOEs of 100. On this basis, risks to mixers/loaders and applicators using ground or aerial application equipment are considered to be acceptable when workers wear coveralls over a long-sleeved shirt, long pants, chemical-resistant gloves, socks and shoes during mixing, loading, application, clean-up and repair. The proposed updates to PPE label statements to reflect current standard requirements for the mixer, loader and applicator are listed in Appendix IX.

3.4.4.2 Postapplication worker exposure and risk assessment

There is potential for postapplication exposure of workers to quizalofop-p-ethyl residues following postemergence application of quizalofop-p-ethyl. Exposure would be of a short-term duration and predominantly dermal for workers performing postapplication activities following spray application. Based on the vapour pressure of quizalofop-p-ethyl (1.1×10^{-7} Pa at 20°C), inhalation exposure is expected to be low, provided that the minimum restricted-entry interval is followed.

Restricted-entry interval are the duration of time that must elapse in order to allow residues to decline to a level where the risks are considered to be acceptable for postapplication worker activities.

Dermal exposure of workers entering treated sites was estimated using activity-specific transfer coefficient (TC) and dislodgeable foliar residue (DFR) values. The DFR refers to the amount of residue that can be dislodged or transferred from a surface, such as leaves of a plant, which is a measurement of pesticide residue on foliage that can be transferred to human skin and clothing. No chemical-specific DFR data was available for quizalofop-p-ethyl. Therefore, a standard DFR value of 25% of the application rate, with a dissipation rate of 10% per day and consideration of the current conditions of use, was used. For the sugarbeets use, a re-treatment interval (RTI) of

14 days was assumed. The TC is a measure of the relationship between exposure and DFR for individuals engaged in a specific activity, and is calculated from data generated in field exposure studies. The TCs are specific to a given crop and activity combination and reflect standard agricultural work clothing worn by workers. The TC values from the Agricultural Re-Entry Task Force (ARTF) were used for this risk assessment. Additional assumptions included an 8-hour workday for all activities, and an average worker body weight of 80 kg. Dermal exposure was adjusted for 50% dermal absorption factor. Toxicology reference values used in the assessment are summarized in Appendix III.

The risk assessment for workers conducting postapplication activities is summarized in Appendix VII. For workers entering treated sites to conduct postapplication activities, the calculated MOEs (ranging from ≥ 165 to ≥ 3210) are above the target MOE of 100 and risks were shown to be acceptable when products are used according to the current use directions. A standard 12-hour REI is proposed to be included on all commercial end-use product labels unless a more restrictive REI is currently listed on the product labels.

In addition, a 14-day RTI is proposed to be specified in the use directions for the sugarbeets use.

The proposed label amendments are listed in Appendix IX.

3.5 Aggregate exposure and risk assessment

Aggregate exposure is the total exposure to a single pesticide that may occur from dietary (food and drinking water), residential and other non-occupational sources, and from all known or plausible exposure routes (oral, dermal, and inhalation).

For quizalofop-p-ethyl, the aggregate assessment consisted of combining food and drinking water exposure only (see Section 3.2.3), since residential exposure is not expected, and is shown to be acceptable. No additional mitigation measures are proposed.

3.6 Cumulative assessment

The *Pest Control Products Act* requires that the PMRA consider the cumulative exposure to pesticides with a common mechanism of toxicity. Quizalofop-p-ethyl belongs to a group of chemicals classified as aryloxyphenoxypropionic herbicides that inhibit acetyl-CoA carboxylase enzyme. This enzyme catalyzes the first committed reaction in fatty acid biosynthesis in both plants and animals; however the mammalian enzyme is not affected by this class of herbicides (PMRA# 3187225, Burke et al. 2014). For the current evaluation, the PMRA did not identify information indicating that quizalofop-p-ethyl shares a common mechanism of toxicity with other pest control products. Quizalofop-p-ethyl does not appear to produce a toxic metabolite produced by other pest control products. At this time, a cumulative assessment is not required.

3.7 Health incident reports

As of 16 March 2022, two minor human incidents involving the active quizalofop-p-ethyl were submitted to the PMRA. In both the incidents, the individuals were inadvertently exposed to the product Assure II Herbicide (PCP Reg No. 25462) either during application or when loading the product. Reported signs in individuals include minor skin and respiratory irritation. The label of

the product does contain appropriate precautionary words as well as protective measures to minimize potential risks when mixing, loading or applying the product. Therefore, based on the reported circumstances of exposure as well as the minor nature of symptoms described in incidents, no additional mitigation measures are recommended based on the incident report review.

4.0 Environmental assessment

4.1 Fate and behaviour in the environment

Chemical structures, physico-chemical and environmental fate properties of quizalofop-p-ethyl (including its racemate, quizalofop-ethyl) and its transformation products are summarized in Appendix VIII, Tables 1–3. Quizalofop-p-ethyl is the active isomer (R(+) enantiomer) of quizalofop-ethyl (racemic mixture of R(+) and S(-) enantiomers). The supporting data for the assessment of the environmental fate and behaviour of quizalofop-p-ethyl consists of a series of laboratory and field studies conducted with the R(+) enantiomer, S(-) enantiomer or racemic mixture. For the purposes of this re-evaluation, the following discussion refers to the active ingredient as quizalofop-p-ethyl.

Terrestrial environment: Phototransformation and hydrolysis are not expected to be major routes of transformation of quizalofop-p-ethyl in soil.

Quizalofop-p-ethyl is non-persistent in soil under both aerobic and anaerobic conditions. The major transformation products (TP) formed in soil are quizalofop-acid, hydroxy-quizalofop, dihydroxy-quinoxaline and 2-(4-hydroxyphenoxy)propionic acid. Quizalofop-acid forms shortly after application of quizalofop-p-ethyl and is the predominant TP in soil. After its initial formation in soil, quizalofop-acid residues slowly decline and based on its dissipation times in soil, it would be classified as moderately persistent to persistent in soil. Quizalofop-acid is persistent. Observations from terrestrial field dissipation studies are consistent with the laboratory studies, showing that quizalofop-p-ethyl is not persistent and quizalofop-acid is the major TP under field conditions.

Quizalofop–p-ethyl is sparingly soluble in water. Laboratory experiments show that quizalofop-p-ethyl has low to moderate mobility in soil. The major transformation products, quizalofop-acid, hydroxy-quizalofop and dihydroxy-quinoxaline have similar mobility profiles as the parent, quizalofop-p-ethyl. A soil column leaching study showed that quizalofop-p-ethyl was mostly retained in the top 5 cm of soil and that quizalofop-acid was found to a depth of 30 cm. A lysimeter study showed that the majority of the recovered residues were in the upper 10 cm soil layer and that quizalofop-acid was the only transformation product formed. No detectable residues were found in the lysimeter leachate. Both quizalofop-p-ethyl and quizalofop-acid were also only found in the upper soil layer in the field. The leaching criteria of Cohen et al. (1984) indicates that both quizalofop-p-ethyl and quizalofop-acid are unlikely to be leachers while using physical properties, Gustafson's (Gustafson, 1989) groundwater ubiquity score (GUS) classifies quizalofop-p-acid as a non-leacher and quizalofop-acid as a non-leacher to leacher; based on the totality of available information, including field data, quizalofop-p-ethyl and its transformation products are unlikely to leach to groundwater.

Aquatic environment: Quizalofop-p-ethyl is stable to hydrolysis at pH 5; however, rates of hydrolysis increase with increasing pH and may contribute to its transformation in the natural environment. Quizalofop-acid is the predominant transformation product, forming at greater than 10 percent. Quizalofop-acid is, however, stable to hydrolysis at pH 5, 7 and 9. Phototransformation of quizalofop-p-ethyl is not expected to be a major route of transformation in water.

Quizalofop-p-ethyl is not persistent in aerobic or anaerobic water and water/sediment systems. Major transformation products formed in test systems with water only include quizalofop-acid, hydroxyl-quizalofop, hydroxy-quinoxaline, dihydroxy-quinoxaline, 2-(4-hydroxyphenoxy)-propionic acid and ethyl-phenoxy-acid. In aerobic water/sediment systems, quizalofop-acid was the only major transformation product formed. Partitioning of quizalofop-p-ethyl into the sediment occurred but not to a significant degree.

Air: Quizalofop-p-ethyl is sparingly soluble in water, has low vapour pressure and a low Henry's law constant. Volatilization of quizalofop-p-ethyl from plant surfaces and moist soil is expected to be minimal. The intrinsic physico-chemical properties, supported by laboratory volatilization tests using plant surfaces and a sandy soil as substrates, suggest that quizalofop-p-ethyl is not likely to volatilize from moist soil or water surfaces under field conditions.

Bioaccumulation: The log K_{ow} of 4.61 for quizalofop-p-ethyl suggests a potential for bioaccumulation, however, a whole body BCF of 290 and 380 shows that quizalofop-p-ethyl is not expected to bioaccumulate in fish. Therefore, bioaccumulation in biota is not expected.

4.2 Environmental risk characterization

The environmental risk assessment integrates the environmental exposure and ecotoxicology information to estimate the potential for adverse effects on non-target species. This integration is achieved by comparing estimated environmental concentrations (EECs) in various media (food, water, soil and air) with concentrations at which adverse effects occur. The EECs are estimated using standard models which take into consideration the application rate(s), chemical properties and environmental fate properties, including the dissipation of the pesticide between applications. The EECs are presented in Appendix VIII, Table 4.

Ecotoxicology information includes acute and chronic toxicity data for organisms (invertebrates, vertebrates and plants) from both terrestrial and aquatic habitats. Effects metrics are the toxicity study endpoints that have been adjusted by an uncertainty factor to account for potential differences in species sensitivity as well as varying protection goals (in other words, protection at the community, population, or individual level). A summary of effects metrics used in the risk assessment is presented in Appendix VIII, Tables 5 and 6.

Initially, a screening level risk assessment is performed to identify pesticides and/or specific uses that do not pose a risk to non-target organisms, and to identify those groups of organisms for which there may be a potential risk. The screening level risk assessment uses simple methods, conservative exposure scenarios (for example, direct application at a maximum cumulative application rate) and the relevant effects metric. A risk quotient (RQ) is calculated by dividing the exposure estimate by an appropriate effects metric, and the risk quotient is then compared to

the level of concern (LOC; Appendix VIII, Table 7). If the screening level RQ is below the LOC, the risk is considered negligible and no further risk characterization is necessary. If the screening level RQ is equal to or greater than the LOC, further characterization of the risk is conducted by taking into consideration more realistic exposure scenarios and effects metrics. These considerations may include additional exposure modelling, monitoring data, results from field or mesocosm studies, and probabilistic risk assessment methods.

The potential risk from the use of quizalofop-p-ethyl was assessed based on one application of 72.0 g a.i./ha, the maximum proposed rate per year (growing season). To calculate the EECs for the transformation products, the application rate for quizalofop-p-ethyl was multiplied by the ratio of the molecular weight of the transformation product and the parent, quizalofop-p-ethyl. This is a conservative estimate and assumes that quizalofop-p-ethyl completely transforms to that transformation product.

4.2.1 Risks to terrestrial organisms

Terrestrial organisms, such as earthworms, pollinators, beneficial arthropods, birds, small mammals, and terrestrial non-target vascular plants can be exposed to quizalofop-p-ethyl through direct contact with spray, spray drift, run-off, contact with sprayed surfaces, or from ingestion of contaminated food. The terrestrial risk assessment for quizalofop-p-ethyl is summarized in Appendix VIII,

Table 8 and 9.

Earthworms and other soil dwelling invertebrates: Quizalofop-p-ethyl and three of its major transformation products for which data are available, quizalofop acid, hydroxy-quizalofop and dihydroxy-quinoxaline, were not acutely or chronically toxic to earthworms and ground-dwelling predatory beetles, *Poecilus cupreus* and *Aleochara bilineata* up to the highest concentration tested or close to the highest concentration tested. The LOC of quizalofop-p-ethyl and its transformation products was not exceeded for earthworms and ground-dwelling predatory beetles (RQs < 0.73).

Bees (pollinators): No treatment-related effects were observed in adult honeybees based on acute oral or contact exposure to the technical grade active ingredient, quizalofop-p-ethyl. When adult honeybees were treated with a formulation containing quizalofop-p-ethyl in acute oral and contact studies, some mortalities were noted; however, RQs (< 0.1) did not exceed the LOC. Effects on chronic adult and larval exposure with quizalofop-p-ethyl were investigated. The LOC (LOC = 0.4) for chronic adult and single exposure (72-hr) honeybee larvae was also not exceeded (RQ = 0.1). In the repeated exposure larval study, honeybee larvae were exposed to quizalofop-p-ethyl over four consecutive days. The RQ (2.7) was just above the LOC (LOC = 1).

Of the available studies with bees, the LOC was exceeded for only one repeated exposure larval study (two studies were provided). No risks were identified for a single exposure to larvae, or acute and chronic effects to adults. The exposure estimate is based on estimated concentrations of the active ingredient in nectar and pollen directly following spray application, whereas some degradation of residues would be expected.

The highest larval food consumption rates are used to calculate risk, however this will also vary and could be lower. Therefore, as the RQ exceeds the LOC by only a small extent, and considering these conservatisms in estimating exposure and that effects were not observed in other life-stages and exposure scenarios, the risk to larvae is acceptable.

Beneficial arthropods: Acute exposure of beneficial arthropods to a quizalofop-p-ethyl formulated product when applied on glass plates did not affect the survival or fecundity of the parasitic wasp, *Aphidius rhopalosiphi*, in a screening study and the LOC (LOC =2) was not exceeded (RQ = 1.5). Acute exposure of quizalofop-p-ethyl formulated product affected the survival of the predatory mite, *Typhlodromus pyri,* in a screening study using glass plates and this resulted in marginally exceeding the LOC (LOC = 2.9). The risk to the predatory mite was further characterized by examining the off-field exposure from drift. To calculate off-field EECs, spray factors are applied to the in-field EECs. The drift factor is defined as the maximum percentage of spray drift deposition at 1 m downwind from the point of application. For quizalofop-p-ethyl, products should be applied using an ASAE medium spray quality (droplet size classification system of the American Society of Agricultural Engineers (ASAE) based on the volume medium diameter (VMD) of spray droplets). The corresponding spray drift factors of 6% for field sprayers and 23% for aerial sprayers, respectively, were used to determine estimated exposure due to spray drift. Based on the RQs calculated using the off-field EECs from spray drift, the LOC for predatory mite was not exceeded for either ground or aerial application (RQs < 0.66). In addition, an extended laboratory study conducted with the parasitic mite, *Typhlodromus pyri,* resulted in the mortality of some adult mites but it did not affect the fecundity. The LOC was not exceeded for the extended laboratory study for predatory mites (RQ = 0.67). Therefore, risks to predatory and parasitic arthropods is considered to be acceptable.

Non-target plants: The effect of quizalofop-p-ethyl to non-target plants was determined through a seedling emergence and vegetative vigour assay using standard crop species. A species sensitivity distribution (SSD) was prepared for quizalofop-p-ethyl using available ER_{50} data for seedling emergence. The SSD analyses were conducted using the publicly available software program ETX (version 2.2). The SSD was used to estimate a hazardous rate to 5% of species (HR_5), which theoretically is the concentration at which 95% of species do not have their acute median effects level (for example, ER_{50}) exceeded. Sufficient data were not available to calculate a SSD for vegetative vigour. As such, the most sensitive endpoint for vegetative vigour should be used in the risk assessment.

The calculated RQs for on-field risk exceeded the LOC at the screening level for seedling emergence (RQ = 1.3) and vegetative vigour (RQ = 124).

The risk to terrestrial non-target plants was further characterized by examining the off-field exposure from drift. Based on the RQs calculated using the off-field EECs from drift, the LOC for seedling emergence was not exceeded for either ground or aerial application (RQs < 0.31). The LOC was, however, exceeded for vegetative vigour for both ground (RQ = 7.4) and aerial (RQ = 28.6) application.

The risk to terrestrial plants is not unexpected as quizalofop-p-ethyl is a herbicide. Spray buffer zones will be required on product labels to protect terrestrial non-target plants.

Birds and mammals: Quizalofop-p-ethyl is practically non-toxic to birds on an acute basis; no treatment-related effects were observed. Some reproductive effects (in other words, hatchability) were seen in bobwhite quail (*Colinus virginianus*), however, no effects were observed in mallard duck (*Anas platyrhynchos*). The RQ for birds resulting from acute oral, dietary or reproductive exposure did not exceed the LOC at the screening level (RQs < 0.1).

The toxicity of quizalofop-p-ethyl to rats was used to determine the risk to small terrestrial mammals. No adverse effects were reported from acute exposure to quizalofop-p-ethyl on an acute basis. The RQ for small mammals resulting from acute exposure to quizalofop-p-ethyl did not exceed the LOC at the screening level (RQs < 0.07).

The multi-generational dietary reproductive exposure of quizalofop-p-ethyl to rats resulted in an decrease in pup body weight. The RQ calculated with the NOAEL resulting from the dietary reproductive exposure did not exceed the LOC at the screening level for small, medium and large sized mammals (RQs < 0.17).

4.2.2 Risks to aquatic organisms

Aquatic organisms, such as invertebrates, fish, amphibians, plants and algae can be exposed to quizalofop-p-ethyl through spray drift or run-off. A risk assessment of quizalofop-p-ethyl is presented in Appendix VIII, Table 0.

The screening level EECs from the use of quizalofop-p-ethyl were determined using the maximum annual foliar application rate of 72 g a.i./ha and assuming direct overspray and instantaneous and complete mixing in the water body accounting for degradation between applications.

Freshwater invertebrates: Quizalofop-p-ethyl, dihydroxy-quinoxaline and quizalofop acid were highly toxic, moderately toxic and slightly toxic, respectively, to *Daphnia magna* in acute toxicity studies. Reproduction was reduced and survival of first generation daphnids was reduced when daphnids were exposed to quizalofop-p-ethyl and quizalofop-acid on a chronic basis, respectively. However, the acute and chronic RQs of quizalofop-p-ethyl and its transformation products for toxicity to daphnids did not exceed the LOC (RQs < 0.39).

No adverse effects were observed when the freshwater midge, *Chironomus riparius*, was exposed to either quizalofop-acid or quizalofop-phenol (RQ < 0.01) at concentrations tested.

Freshwater fish and amphibians: Quizalofop-p-ethyl was highly toxic to rainbow trout and bluegill sunfish (acute studies). No adverse effects were observed in freshwater fish exposed to quizalofop-p-ethyl transformation products, quizalofop-acid and dihydroxy-quinoxaline, on an acute basis but adverse effects were seen when they were exposed to quizalofop-acid on a chronic basis.

The RQs for freshwater fish for both quizalofop-p-ethyl and its transformation products did not exceed the LOC on an acute or chronic basis (RQs < 0.43).

The risk to amphibians was assessed using the most sensitive fish toxicity value (bluegill sunfish for acute and rainbow trout for chronic exposure) as a surrogate endpoint. This resulted in an acute and chronic screening level RQ of 2.3 and 1.1, respectively, both of which marginally exceeded the LOC. When the risk was further characterized by examining the off-field exposure from drift, the LOC for amphibians was not exceeded for either ground or aerial application for both acute and chronic exposure (RQs < 0.53). Based on risks identified at the screening level, a 1 m buffer zone will be required for amphibian habitats. As the RQs marginally exceeded the LOC (maximum RQ of 2.3) it was determined that risks from runoff would be acceptable and that further characterization due to runoff was not needed. However, standard label statements for runoff will be required.

As quizalofop-p-ethyl is rapidly transformed to quizalofop-acid and as quizalofop-acid is more persistent than quizalofop-p-ethyl, the acute risk to quizalofop-acid would more appropriately characterize the risk of quizalofop-p-ethyl to amphibians.

The acute and chronic screening risk of amphibians, using rainbow trout data as surrogate, to quizalofop-acid did not exceed the LOC (RQs < 0.01). Therefore, exposure of quizalofop-p-ethyl and its transformation products is not expected to pose an unacceptable risk to freshwater fish and amphibians.

Freshwater algae and vascular plants: Quizalofop-p-ethyl and its major transformation products, quizalofop acid, hydroxy-quizalofop-p and dihydroxy-quinoxaline, were not acutely or chronically toxic to duckweed, *Lemna gibba,* and freshwater cyanobacterium ("blue-green alga"; *Anabaena flos-aquae*) up to the highest concentration tested. Exposure of the freshwater green algae (*Selenastrum capriconutum/Pseudokirchneriella subcapitata*) to quizalofop-p-ethyl and a formulated product resulted in some growth inhibition. The RQ of quizalofop-p-ethyl and quizalofop-acid to these indicator freshwater algae and vascular plant species did not exceed the screening level LOC (RQs < 0.86).

Marine/estuarine species: Quizalofop-p-ethyl was very highly toxic, based on the United States Environmental Protection Agency toxicity classification system, to Eastern oyster (*Crassostrea virginica*) based on acute shell deposition and embryo larvae at the highest test concentrations tested. The screening level LOC was not exceeded for shell deposition or larval toxicity for Eastern oyster (RQ < 0.23). Quizalofop-p-ethyl was highly toxic to mysid shrimp (*Mysidopsis bahia*) on an acute basis however the LOC was not exceeded (RQ = 0.12). Quizlofop-p-ethyl was moderately toxic to sheepshead minnow on an acute basis and the LOC was not exceeded (RQ = 0.05). The effects of quizalofop-p-ethyl to marine algal species was not assessed, however, based on the results from the freshwater algal species, quizalofop-p-ethyl is not expected to pose a risk to marine algal species.

Petroleum distillates:

Product formulations of quizalofop-p-ethyl contain solvesso-like petroleum distillates (SPDs). An assessment was conducted to determine if the SPD levels in products would pose a risk to aquatic organisms under conditions of use. Based on the levels of SPDs and the maximum application rate for the registered formulations, environmental risk mitigation measures are required.

A precautionary label statement and buffer zones to protect aquatic habitats will be required on all product labels.

4.2.3 Environmental incident reports

As of 16 March 2022, no environment incident reports involving quizalofop-p-ethyl have been submitted to Health Canada. The United States Ecological Incident Information System (EIIS) database was also queried for environment incident information. As of October 2015, three incidents were reported in plants. All three incidents were considered to be possibly related to the applied pesticide and involved plant damage and/or mortality in soybeans. A risk to terrestrial plants was identified in the risk assessment and will be mitigated through the requirement of spray buffer zones.

4.3 Toxic substances management policy considerations

The Toxic Substances Management Policy (TSMP) is a federal government policy developed to provide direction on the management of substances of concern that are released into the environment. The TSMP calls for the virtual elimination of Track 1 substances, in other words, those that meet all four criteria outlined in the policy: persistent (in air, soil, water and/or sediment), bio-accumulative, primarily a result of human activity and toxic as defined by the *Canadian Environmental Protection Act*. The *Pest Control Products Act* requires that the TSMP be given effect in evaluating the risks of a product.

During the review process, quizalofop-p-ethyl and its transformation products were assessed in accordance with the PMRA Regulatory Directive DIR99-03[3] and evaluated against the Track 1 criteria. The PMRA has reached the conclusion that quizalofop-p-ethyl and its transformation products do not meet all of the TSMP Track 1 criteria. Please refer to Appendix VIII, Table 11, for further information on the TSMP assessment.

4.3.1 Formulants and contaminants of health or environmental concern

During the review process, contaminants in the technical grade active ingredient and formulants and contaminants in the end-use products are compared against Parts 1 and 3 of the *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern*.[4] The list is used as described in the Health Canada's Science Policy Note SPN2020-01[5] and is based on existing policies and regulations including the TSMP**Error! Bookmark not defined.** and Formulants Policy,[6] and taking into consideration the Ozone-depleting Substances and

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[3] DIR99-03, *The Pest Management Regulatory Agency's Strategy for Implementing the Toxic Substances Management Policy.*

[4] SI/2005-114, last amended on June 24, 2020. See Justice Laws website, Consolidated Regulations, *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern*.

[5] PMRA's Science Policy Note SPN2020-01, *Policy on the List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern* under paragraph 43(5)(b) of the *Pest Control Products Act.*

[6] DIR2006-02, *Formulants Policy and Implementation Guidance Document*.

Halocarbon Alternatives Regulations under the *Canadian Environmental Protection Act*, 1999 (substances designated under the Montreal Protocol).

Health Canada has reached the conclusion that quizalofop-p-ethyl and its end-use products do not contain any formulants or contaminants identified in the *List of Pest Control Product Formulants and Contaminants of Health or Environmental Concern*.

The use of formulants in registered pest control products is assessed on an ongoing basis through PMRA formulant initiatives and Regulatory Directive DIR2006-02.

5.0 Value assessment

Quizalofop-p-ethyl has value to Canadian producers due to its selectivity for annual and perennial grasses along with its broadleaved crop tolerance. It is one of the broadest spectrum grass herbicides and one of few herbicides providing control of perennial grassy weeds available to Canadian growers. It has been reported as one of the most efficient herbicides at controlling quackgrass, which is troublesome and difficult to control. It is widely used in a variety of crops grown in Canada such as pulses, oilseeds and other specialty crops. It is the only herbicide registered for use on hemp and Ethiopian mustard. It is one of few herbicides registered for use in seed corn with a tolerance to other herbicides identified as having Enlist^{TM} traits.

List of abbreviations

a.i.	active ingredient
abs.	absolute
AD	administered dose
ADI	acceptable daily intake
A/G	albumin/globulin ratio
AHETF	Agricultural Handlers Exposure Task Force
ALP	alkaline phosphatase
ALT	alanine aminotransferase
AopWin	Atmospheric Oxidation Program for Windows
AR	applied radioactivity
ARfD	acute reference dose
ARTF	Agricultural Re-Entry Task Force
ASAE	American Society of Agricultural Engineers
AST	aspartate aminotransferase
ATPD	area treated per day
BAF	bioaccumulation factor
BCF	bioconcentration factor
BUN	blood urea nitrogen
bw	body weight
bwg	body-weight gain
Ca	calcium
CAF	composite assessment factor
ChE	cholinesterase
CHL	Chinese hamster lung fibroblast cell
CHO	Chinese hamster ovary cell
Cl	chloride
cm	centimeter
cm^2	square centimeter
d	day
DAT	days after treatment
DFOP	First-Order in Parallel
DFR	dislodgeable foliar residue
DNA	deoxyribonucleic acid
DR	dose response
DT_{50}	dissipation time 50% (time required to observe a 50% decline in concentration)
DT_{90}	dissipation time 90% (time required to observe a 90% decline in concentration)
dw	dry weight
EC	emulsifiable concentrate
EC_{50}	effective concentration to 50% of the population
EDE	estimated daily exposure
EEC	estimated environmental concentration
EFSA	European Food and Safety Authority
EQP	racemic quizalofop-ethyl
F_1	first generation
F_2	second generation
fc	food consumption

fe	food efficiency
FIR	Food ingestion rate
FMOC	First-Order Multi-Compartment
g	gram(s)
GD	gestation day
GI	gastrointestinal
GLP	good laboratory practice
GUS	Groundwater Ubiquity Score
ha	hectare
Hb	hemoglobin
HC	historical control
HDT	highest dose tested
HGPRT	hypoxanthine-guanine phosphoribosyl transferase
hr(s)	hours
IORE	Indeterminate Order Rate Equation Model
i.v.	intravenous
kg	kilogram(s)
KOAWin	Octanol Air Partition Coefficient Program for Microsoft Windows
K_{oc}	organic carbon-water partition coefficient
$K_{oc\text{-}ads}$	adsorption organic carbon-water partition coefficient
K_{ow}	octanol-water partition coefficient
L	liter
LC_{50}	lethal concentration to 50%
LD	lactation day
LD_{50}	lethal dose to 50%
LDH	lactate dehydrogenase
LOAEL	Lowest Observed Adverse Effect Level
LOC	level of concern
log K_{ow}	n-octanol–water partition coefficient
LR_{50}	lethal rate 50%
m	meter
max	maximum
mg	milligram(s)
mL	millilitre
mM	millimolar
MAS	maximum average score for 24, 48 and 72 hours
MCH	mean corpuscular hemoglobin
MCHC	mean corpuscular hemoglobin concentration
MCV	mean corpuscular volume
MIS	maximum irritation score
MOE	margin of exposure
MTD	Maximum tolerated dose
N/A	not applicable
Na	sodium
NOAED	No Observed Adverse Effect Dose
NOAEDD	No Observable Adverse Effect Dietary Dose
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration

NOEL	No Observed Effect Level
nss	not statistically significant
P	parental generation
PCPA	*Pest Control Product Act*
PCV	packed cell volume
PHED	Pesticide Handlers Exposure Database
PMRA	Pest Management Regulatory Agency
PND	postnatal day
PPA	2-(4-hydroxyphenoxy) propionic acid
PPE	personal protective equipment
ppm	parts per million
QP	Quizalofop-acid
QPE	quizalofop-P-ethyl, the R-isomer of racemic quizalofop-ethyl (EQP)
RBC	red blood cell
REI	restricted-entry interval
rel.	relative
RfD	reference dose
RQ	risk quotient
RTI	retreatment interval
SFO	Single First-Order
SPD	solvesso-like petroleum distillate
ss	statistically significant
SU	Suspension
TC	transfer coefficient
TLC	thin layer chromatography
TP	transformation product
Tr	representative half-life
TSMP	Toxic Substances Management Policy
UE	unit exposure
UF	Uncertainty factor
UK	United Kingdom
USEPA	United States Environmental Protection Agency
wk(s)	week(s)
WP	wettable powder
wt	weight
♂	males
♀	females
↑	increased
↓	decreased
°C	degree(s) Celsius
%	percent
14C	carbon-14
µCi	microcurie
µg	microgram(s)

Appendix I Registered products containing quizalofop-p-ethyl in Canada[1]

Registration Number	Marketing Class **	Registrant	Product Name	Formulation Type	Guarantee
25461	T	AMVAC Canada ULC	Quizalofop-p-ethyl Technical Herbicide	solid	98%
29392	T	Nissan Chemical Corporation	Quizalofop-p-ethyl MUP Herbicide	solid	98%
33269	T	Sharda Cropchem Limited	Sharda Quizalofop-p-ethyl Technical Herbicide	solid	95.7%
33340	T	Adama Agricultural Solutions Canada LTD.	Adama Quizalofop-p-ethyl Technical	solid	95.67%
33374	T	NewAgco inc.	Newagco Quizalofop-p-ethyl Technical	solid	98%
33730	T	Agrogill Chemicals Pty Ltd	Quizalofop-p-ethyl Agrogill Technical Grade Active Ingredient	solid	98.8%
30068	M	Nissan Chemical Corporation	Yuma™ Bulk Herbicide	emulsifiable concentrate	96 g/L
25462	C	AMVAC Canada ULC	Assure II Herbicide	emulsifiable concentrate	96 g/L
29134	C	Nissan Chemical Corporation	Yuma Herbicide	emulsifiable concentrate	96 g/L
30100	C	Nissan Chemical Corporation	Yuma ® GL Liquid EC Herbicide	emulsifiable concentrate	96 g/L
32091	C	Nissan Chemical Corporation	Ipco Contender Herbicide	emulsifiable concentrate	96 g/L
33481	C	NewAgco Inc.	Quiz Herbicide	emulsifiable concentrate	96 g/L
33617	C	Sharda Cropchem Limited	Elegant10 EC	emulsifiable concentrate	96 g/L

Registration Number	Marketing Class **	Registrant	Product Name	Formulation Type	Guarantee
33681	C	Nissan Chemical Corporation	Marshall	emulsifiable concentrate	96 g/L
33715	C	ADAMA Agricultural Solutions Canada Ltd	Leopard	emulsifiable concentrate	100g/L
33835	C	Agrogill Chemicals Pty Ltd	Agrogill Quizalofop-p-ethyl Herbicide	emulsifiable concentrate	96 g/L
33906	C	Nufarm Agriculture Inc	Idol Herbicide	emulsifiable concentrate	96 g/L
33960	C	Interprovincial Cooperative Ltd.	IPCO Contender II Herbicide	emulsifiable concentrate	96 g/L
33961	C	Interprovincial Cooperative Ltd.	Co-op Contender II Herbicide	emulsifiable concentrate	96 g/L
34034	C	NewAgco, Inc.	Quizalofop-p-ethyl 96 G/L Herbicide	emulsifiable concentrate	96 g/L
34282	C	BASF Canada Inc.	Caziva™ Ultra Q	emulsifiable concentrate	96 g/L

* As of 4 January 2022, excluding discontinued products or products with a submission for discontinuation.
** T = Technical Grade Active Ingredient, C = Commercial, M = Manufacturing Concentrate

Appendix II Registered uses of Quizalofop-p-ethyl in Canada as of 12 October 2021[1]

Use-site categories	Sites[2]	Maximum application rate[3] (g a.i./ha)		Application method and equipment
		Single	Cumulative per year	
7 - **Terrestrial Non-food and Non-feed Seed and Fibre Crops** 13 – Terrestrial Feed Crops 14 – Terrestrial Food Crops	Canola (rapeseed)	36.5–72	72	Ground or aerial
	Glufosinate ammonium tolerant canola varieties (Liberty Link canola)	36.5–72 (in tankmix with Liberty 150 SN)	72 (in tankmix with Liberty 150 SN)	Ground or aerial
	Soybeans (including varieties designated "STS") STS stands for Sulfonylurea Tolerant Soybean	36.5–72	72	Ground or aerial
	Field and seed corn containing the Enlist™ corn herbicide trait	36.5–72	72	Ground
	Industrial hemp grown for fibre, seed and oil (Note: Products PCP# 29134, 29625 and 30100 are for fibre production only)	36.5–72	72	Ground
13 – Terrestrial Feed Crops 14 – Terrestrial Food Crops	*Camelina sativa*	36.5–72	72	Ground
	Flax (including low linolenic acid varieties)	36.5–72	72	Ground or aerial
	Narrow leaf lupin	36.5–72	72	Ground
14 – Terrestrial Food Crops	Lentils	36.5–72	72	Ground or aerial
	Peas (field and processing)	36.5–72	72	Ground or aerial
	Chickpea (Western Canada only)	36.5–72	72	Ground
	Oriental mustard (including canola quality *brassica juncea*) (condiment and oilseed type) (Western Canada only)	36.5–72	72	Ground or aerial
	Yellow and brown mustard (Western Canada only)	36.5–72	72	Ground or aerial
	Crambe (Western Canada only)	36.5–72	72	Ground or aerial

Use-site categories	Sites[2]	Maximum application rate[3] (g a.i./ha)		Application method and equipment
		Single	Cumulative per year	
	Ethiopian mustard (*Brassica carinata*) (Western Canada only)	36.5–48	48	Ground or aerial
	Saskatoon berries (Western Canada only)	36.5–72	72	Ground
	Sunflowers	36.5–72	72	Ground or aerial
	Tribenuron-methyl tolerant sunflowers	36.5–72 (in tank mix with tribenuron-methyl)	72 (in tank mix with tribenuron-methyl)	Ground or aerial
	Snap beans	36.5–72	72	Ground
	Sugarbeets	36.5–72	72	Ground
	All dry common beans of the species *Phaseolus vulgaris* including but not limited to all dry common bean types listed on the labels	36.5–72	72	Ground
	Pinto, navy, great northern, pink and small red beans (Western Canada only)	36.5–72	72	Ground
	Pinto, pink, great northern and small red beans (Western Canada only)	60.5 (in tank mix with Basagran)	60.5 (in tank mix with Basagran)	Ground
	White, white and red kidney, cranberry, black, brown and yellow eye, lima, mung, otebo and adzuki beans (Southern Ontario only)	36.5–72	72	Ground
	Dry faba beans (dry broad beans) and narrow leaf lupin	36.5–72	72	Ground
	Rutabagas (Ontario and Quebec only)	36.5–72	72	Ground
14 – Terrestrial Food Crops	Group 9 – Cucurbit vegetablesincluding: citron melon; cucumber; gherkin; edible gourd (hyotan, cucuzza); Chinese okra; Chinese cucumber; muskmelon hybrids and or cultivars of Cucumis melo including true cantaloupe, cantaloupe, casaba, crenshaw melon, golden pershaw melon,	36.5–72	72	Ground

Use-site categories	Sites[2]	Maximum application rate[3] (g a.i./ha)		Application method and equipment
		Single	Cumulative per year	
	honeydew melon, honey balls, mango melon, Persian melon, pineapple melon, Santa Claus melon, and snake melon; pumpkin; summer squash including crookneck squash, scallop squash, straightneck squash, vegetable marrow, and zucchini; winter squash including butternut squash, calabaza, hubbard squash, acorn squash, spaghetti squash; watermelon including hybrids and/or varieties of Citrullus lanatus			
7 - **Terrestrial Non-food and Non-feed Seed and Fibre Crops**	Seed alfalfa	36.5–72	72	Ground or aerial
	Seedling legumes for seed production (for bird's-foot trefoil, alsike, red, white and sweet clover and sainfoin)	48–72	72	Ground
	Established red and alsike clovers for seed production only	36.5–72	72	Ground
	Seedling or established creeping red fescue for seed production only	48–72	72	Ground

1. Uses from discontinued products or products with a submission for discontinuation are excluded.

   Weeds controlled:
   Green foxtail, volunteer barley, volunteer corn, volunteer oats, volunteer wheat, wild oats, barnyard grass, wild oats, fall panicum, old witchgrass, proso millet, yellow foxtail, foxtail barley, downy brome, Japanese brome and quackgrass

2. Sites are either as stated on the product label or as interpreted by the PMRA so as to achieve consistency in naming.

3. Rates of active ingredient (a.i.) were calculated by the PMRA. Note that the maximum number of applications per year was not stated on registered end use product labels but was interpreted by PMRA based on the label instructions for each end use product. The maximum number of applications is once per year for all sites except sugarbeets where a second application can be applied for control of second flush of annual grasses or volunteer cereals.

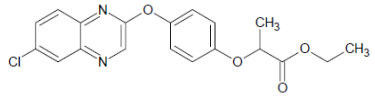
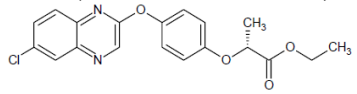
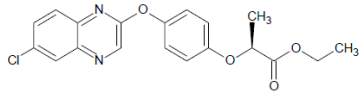
Appendix III Toxicology information

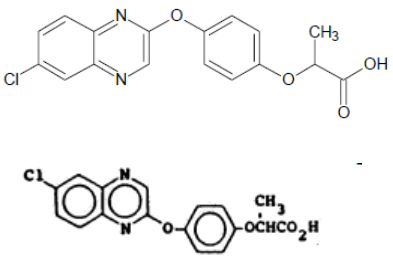
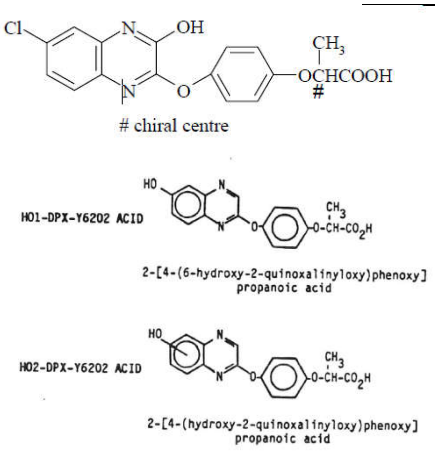
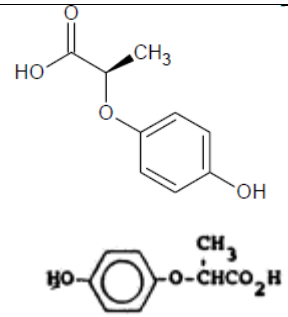
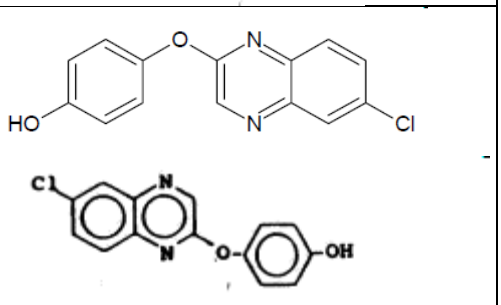
Table 1 Toxicology reference values for the human health risk assessment of Quizalofop-p-ethyl

Exposure scenario	Study	Point of departure and endpoint	CAF[1] or target MOE
Acute dietary All populations	An endpoint of concern attributable to a single exposure was not identified in the oral toxicity studies		
Repeated dietary All populations	24 month dietary chronic toxicity study in rats	NOAEL = 0.9/1.1 mg/kg bw/day (♂/♀) based on liver histopathology and mild anemia	100
	ADI = 0.01 mg/kg bw/day		
Short-term dermal[2] and inhalation[3]	2-generation dietary reproductive toxicity study in rats	Offspring NOAEL= 2.6 mg/kg bw/day based on liver effects	100
Cancer Risk	A threshold-based cancer risk assessment approach was used to address liver tumours in mice.		

[1] CAF (composite assessment factor) refers to a total of uncertainty and PCPA factors for dietary assessments; MOE refers to a target MOE for occupational assessments
[2] A dermal absorption factor of 50% was established
[3] An inhalation absorption factor of 100% (default value) was used in route-to-route extrapolation

Table 2 Identification of quizalofop-ethyl, quizalofop-p-ethyl and select metabolites of quizalofop-p-ethyl in rats

Chemical name	Code/name	Structural diagram
Ethyl-2-[4-(6-chloroquinoxaline-2-yloxy)-phenoxy]propanoate (Quizolafop-ethyl, EQP) made of: Ethyl (R)-2-[4-(6-chloroquinoxaIin-2-yloxy)phenoxy] Propionate or (RS)-tetrahydrofurfuryl (R)-2-[4-(6-chloroquinoxalin-2-	D(+) NC302 (QPE) L(-) NC302 or FBC 32187 or DPX-Y6202	EQP:  QPE (EQP R enantiomer):  EQP (S enantiomer) 

Chemical name	Code/name	Structural diagram
yloxy)phenoxy]propionate (Quizolafop-P-ethyl, QPE); Ethyl (S)-2-[4-(6-chIoroquinox~in-2-yloxy)phenoxy] propanoate		
2-[4-(6-chloroquinoxalin- 2-yloxy)phenoxy]propanoic acid	EQP-acid, QPE-acid IN-B6729 NC-302 acid or DPX-Y6202 acid Quizalofop acid	
2-[4-(6-Chloro-3-hydroxyquinoxalin-2-yloxy)phenoxy]propionic acid	HO1-DPX-Y6202 acid and HO2-DPX-Y6202 acid Hydroxy-quizalofop QUIZ-OH Hydroxy-quizalofop acid 3-OH-Quizalofop-acid OH-Quizalofop Hydroxy propaquizafop acid	
2-(4-hydroxyphenoxy)propionic acid; 2-(4-hydroxyphenoxy)-propanoic acid; (R)-2-(4-hydroxyphenoxy)propionic acid	PPA Compound 6 Phenoxy acid Phenol 4 Phenol 3 acid	
4-(6-chloroquinoxalin-2-yloxy)-phenol	NC-302 phenol (phenol 1) Quizalofop-phenol Phenol 1 Hydroxyl ether CQOP QHQ	

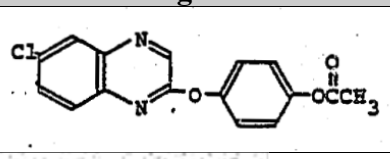
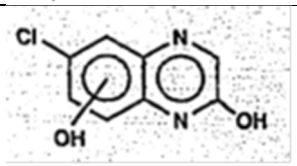
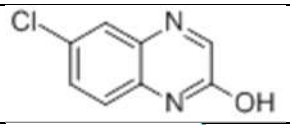
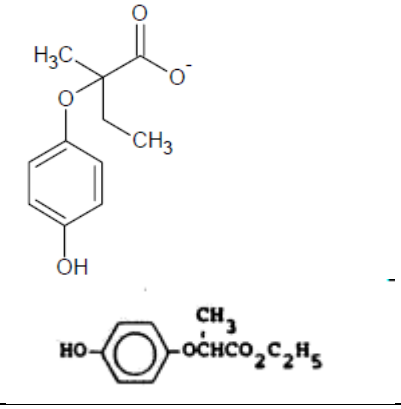
Chemical name	Code/name	Structural diagram
4-[(6-chloroquinoxalin-2-yl)oxy]phenyl acetate	EQP-acetate	
Hydroxylated 2-Hydroxy-6-chloroquinoxaline	Dihydroxy-quinoxaline OH-QPE Phenol 2 CHQ	
2-Hydroxy-6-chloroquinoxaline	Hydroxy-quinoxaline QPE/EQP-Phenol 2	
Ethyl-2-(4-hydroxyphenoxy)-propanoate	NC-302 phenoxy-acid EPP EQP-phenol 3 Compound 5 Ethyl-hydroxyphenoxy propionate Phenol 3	

Table 3 Toxicity profile for quizalofop-p-ethyl

Effects observed in both sexes are presented first followed by sex-specific effects in males, then females, each separated by semi-colons. Organ weight effects reflect both absolute organ weights and relative organ to body weights unless otherwise noted.

Study Type/Animal/PMRA#	Study results
Toxicokinetic Studies	
Absorption, Distribution, Metabolism and Excretion (single low dose) (i.v.) Quizalofop-ethyl (EQP) Sprague-Dawley CD rat PMRA# 1224042	^{14}C- EQP labelled at the phenyl ring dissolved in dimethyl acetamide at **10 mg/kg bw** (2-5 µCi/rat). **Absorption**: Data on biological elimination half-lives in blood indicated that even tissue distribution of the i.v. injected dose was attained within 0.4–0.5 hr. **Distribution**: Tissue autoradiograms indicated that high concentrations of radioactivity occurred in the blood, liver, lungs, kidneys, intestines, teeth, and skin with very little in other tissues within 1 hr and in all these tissues except the teeth and skin at 3, 9 and 24 hr. By 72 and 168 hrs only small amounts of radioactivity were observed. After 7 days, radioactive residues in the body were 3.4% AD and 2.1% AD in ♂s

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	and ♀s, respectively with 0.8–0.9% AD in fur. **Metabolism**: Four metabolites were detected in urine, the major ones were 2-(4-(6-chloro-2-quinoxalyloxy)phenoxy) propionic acid (EQP acid) and PPA. Metabolites in feces were similar to those in urine but no unchanged EQP was detected in either feces or urine. **Excretion**: 87% AD (♂) and 90% AD (♀) was excreted in urine and feces during 7 day period with 27% (♂) and 29 (♀) excreted after 48 hrs; most excreted in feces (71% (♂) and 51% (♀)) with smaller amounts in urine (17% (♂) and 39% (♀)).
Absorption, Distribution, Metabolism and Excretion (single high dose) (gavage) Quizalofop-ethyl Sprague-Dawley CD rat PMRA# 1224042	^{14}C- EQP labelled at the phenyl ring, quinoxaline ring diluted with non-radioactive EQP and suspended in 1% Tween 80, at 160 mg/kg bw (approx. 5 µCi/mL/rat) **Absorption**: The peak concentration in each tissue occurred at 6–9 hrs except in the fat and adrenal gland (24 and 3 hrs, respectively). **Distribution**: Highest concentrations occurred in plasma, liver, whole blood and kidneys with lowest levels in the brain. Peak levels in ♀s were somewhat higher than in ♂s and the disappearance rates from tissues were higher (the biological half-life from the blood was 27 hr in ♂s and 19 in ♀s) up to 168 hrs after dosing. The biological half-life in fat was 155 hrs in ♂s compared with 32 to 36 hrs in most other tissues and 60.5 hrs in brown fat. Whole body autoradiograms in ♂ rats indicated that at 0.25 hr after dosing, high concentrations of radioactivity occurred in the gullet and small intestines, and after 6 hrs large amounts were seen in the intestines, followed by blood, liver, lungs, kidneys, marrow and teeth. Low levels occurred in the heart, tongue, fur salivary glands, brown fat, skin and testes with no radioactivity in the brain or spinal cord. By 120 hrs little radioactivity was seen in any tissue. Only 2.0 and 3.1% of the AD remained in tissues of ♂s and ♀s respectively 7 days after dosing. **Excretion**: Administration of ^{14}C-phenyl-EQP and ^{14}C-quinoxaline-EQP at 160 mg/kg bw to ♂ rats resulted in 8% AD and 8% AD respectively in the urine and 85% AD and 81% AD, respectively of the ^{14}C-radiolabel in the feces. In ♀s, given 160 mg/kg bw ^{14}C-phenyl-EQP, 26% AD was excreted in the urine and 73% AD in the feces. Biliary excretion during 0–24 hrs in ♂ rats receiving 160 mg/kg bw ^{14}C-phenyl-EQP was 22% of the AD.
Absorption,	^{14}C-EQP labelled at the quinoxaline ring, suspension in 1% Tween 80,

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Distribution, Metabolism and Excretion (repeat low dose) (gavage) Quizalofop-ethyl Sprague-Dawley CD rat (♂) PMRA# 1224042	at **1.5 mg/kg bw/day** (2 µCi) for 1, 7, 14 or 28 days **Absorption**: Concentrations in each tissue reached maximum levels after 7 consecutive daily doses and then decreased thereafter. After 14 days of dosing tissue levels of ^{14}C were only two to threefold those after a single dose and after 28 days were only one to twofold higher. It is not known if this was due to a decline in absorption or to an increase in the rate of excretion. **Distribution**: In whole body autoradiographed rats, 24 hrs after final administration of ^{14}C-EQP, the highest levels of radioactivity were seen in the intestines followed by blood, liver, kidney, lung, tooth > tongue, skin, marrow, fat > fur, heart, salivary glands, adrenal, brown fat > testis, thymus, and spleen. At 72 hrs high levels of radioactivity were seen in the intestines with low levels in other tissues and by 120 hrs only traces were seen in intestines, blood, liver, fur, fat, and brown fat. Bound residues in the liver increased from 3% AD after 1 day of dosing to 10% AD after 28 days indicating that covalent binding of EQP and/or its metabolites to liver tissue was not large. **Excretion**: In each tissue, except the fat, the rate of elimination was similar after 7, 14 or 28 days of dosing. With fat, the elimination rate was more prolonged after longer periods of dosing, although the concentrations in fat measured 24 hrs after the final dose for the 7-, 14- or 28-day dosing regimens were 1.71 (maximum concentration achieved), 1.21 and 0.87 µg/g respectively. The radiolabelled concentrations in the fat measured 72 hrs after the final dose for the 7-, 14- or 28-day dosing regimens were: 1.00, 1.11, and 1.08 µg/g respectively; at 120 hrs were: 0.63, 0.76, and 1.01 µg/g respectively; and at 168 hrs were: 0.50, 0.69 and 0.92 µg/g respectively, indicating a gradual decrease with time, albeit slow. It was concluded that uptake of ^{14}C into fat was saturated to a small degree.
Absorption, Distribution, Metabolism and Excretion (single high dose) (gavage) Quizalofop-ethyl Sprague-Dawley CD rat PMRA# 1224042	^{14}C-EQP, labelled at the phenyl ring with 1% Tween 80, at **160 mg/kg bw** (approximately 5 µCi/mL/rat) **Metabolism**: Major urine metabolites of ^{14}C-phenyl-EQP were EQP acid and PPA, which accounted for 33% and 37%, respectively, of urinary radioactivity 0–48 hrs after dosing in ♂ and 46 and 27.5%, respectively, in ♀. In 0–48 hr feces of ♂ and ♀, unchanged EQP accounted for 44% (32% AD) and 38% (22.5% AD) of fecal radioactivity. Fecal metabolites were similar to those in urine with EQP acid and PPA accounting for 24.1 and 8.7%, respectively, in ♂ and 23.5 and 15.1%, respectively, in ♀, of fecal radioactivity. The major metabolites in bile were the EQP acid and it β–glucuronide conjugate.

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	(approximately 30% of the bile radioactivity was EQP acid and the remainder at the origin when incubated with β–glucuronidase yielded about 50% EQP acid). EQP acid was a main metabolite in liver and accounted for 72–85% of liver radioactivity. Small amounts of other metabolites were also detected including EQP phenol (urine, feces, bile, liver) and EQP acetate (urine, feces, bile). **Excretion**: During the 0–48 hrs after the single oral dose of ^{14}C-phenyl-EQP, 5% and 73% AD were excreted in urine and feces of ♂ rats, and 16.5% and 59% AD for ♀. ♂ rats given ^{14}C-quinoxaline-EQP excreted 5% and 73% AD in urine and feces respectively.
Absorption, Distribution, Metabolism and Excretion (repeat low dose) (gavage) Quizalofop-ethyl Sprague-Dawley rat (♂) PMRA# 1224252	^{14}C-EQP in 1% aqueous Tween 80 at **1.5 mg/kg bw/day** (in 5 mL/kg bw) for 28 days followed by 8 day recovery period **Absorption**: Highest radiolabel was in blood after 3 days of dosing. **Distribution**: Highest radioactivity levels were present in the liver, kidney, muscle and fat after 7 days of dosing. Levels in all tissues declined during the 8 day withdrawal period to about 80–90% of the initial levels (measured on day 2 of recovery), except body fat which remained virtually unchanged; however upon closer examination, levels in fat spiked slightly on day 4 of recovery, and slowly declined thereafter. Thus the radiolabelled residue level only seemed unchanged on day 8 of recovery when compared to initial measurement (on day 2 of recovery), which was already 30% lower than the measurement taken on the last day of dosing (day 28). Autoradiography showed highest levels in most tissues after 7 days of dosing, with the highest levels in the GI tract with lower levels in the liver, kidneys, blood, pulp cavities of the teeth, hair follicles, skin, fur, lungs and epimysium. Lowest levels were present in the muscle, fat, thymus, adrenals, pituitary, salivary glands, intra-orbital lachrymal gland, Harderian gland, nasal mucosa, lymph nodes, testis, epididymides, brown fat, seminal vesicles and prostate. Little change in distribution was noted thereafter except for a slight decline in concentration up to 28 days.
Absorption, Distribution, Metabolism and Excretion (single low dose) (gavage) Quizalofop-ethyl	^{14}C-EQP in 1% aqueous Tween 80 at **1.5 mg/kg bw/day** (31.3 µCi/kg bw) **Absorption**: Peak plasma level of 3% of the dose/mL occurred 6 hrs post-dosing and declined with a half-life of 31 hrs between 6 and 168 hrs. Based on radioactivity recovered in urine, feces and bile, it was calculated that 67% and 89% of a single oral low dose was absorbed in ♂ and ♀, respectively (24 hrs).

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Sprague-Dawley CD rat PMRA# 1224253	**Distribution**: After 5 days, approximately 6–8% of the AD remained, with 2.2%, 0.6% and 5.6% in the GI tract, liver and carcass of the ♂s and 1.5%, 0.5% and 3.8%, respectively, in ♀s. Highest radioactivity concentrations were seen in plasma at 6 hrs in both sexes, except in fat. Next highest concentrations at 6 hrs (♂) were whole blood, GI tract, thyroid, liver and kidneys and in ♀, in whole blood, GI tract, liver, kidneys, ovaries and thyroid. At 168 hrs, radiolabel in the fat was highest of all tissues in ♂s, versus third highest in ♀s, behind the GI tract and plasma. **Metabolism**: Metabolites were characterized by TLC only. At least five components were found in urine of both sexes. One of the components was more prevalent in ♀s (22% AD) than in ♂s (3% AD). The amounts of the other metabolites were similar in both sexes. In bile, one major component at RfD 0.5 in both sexes accounted for about half the radioactivity (the remaining activity was found at the origin). No unchanged parent material was detected in urine or bile. In feces unchanged parent material accounted for 5% of the extract. The majority of activity (66–72%) was found at RfD 0.5 with the remaining material in four bands (plus the origin) accounting for 1–11% of the AD. **Excretion**: Within 24 hrs, 25% of the AD in ♂s and 20% AD in ♀s was excreted in the urine and feces, respectively. During the 5 days post-dosing, ♂ rats excreted 95.5% of the AD, 21% of which was in the urine and 74.5% in the feces. In ♀s, total excretion within 5 days accounted for 99% of the AD, with 50% in urine and 49% in feces. Within 24 hrs of dosing, 30%, and 22% of AD was excreted in the bile of ♂ and ♀ respectively (n=1); and within 48 hrs, 52% and 49% of AD was excreted in ♂s and ♀s respectively.
Absorption, Distribution, Metabolism and Excretion (single low dose)(gavage) Quizalofop-ethyl Charles River CD rat PMRA# 1224185	Quinoxaline - ^{14}C EQP, labelled in the phenyl portion of the quinoxalinyl ring, diluted with unlabelled EQP in ethanol: corn oil (1:9) at **16 mg/kg bw** (2 mL/kg bw) **Distribution**: Organ and tissue retention of radioactivity was low, with highest concentrations in the skin and GI tract of ♂, and hide of ♀. Minimal levels were found in the brain, heart, muscle, spleen and gonads of both sexes. **Metabolism**: The distribution of metabolites in the organs and tissues showed that EQP acid was in the highest concentration (61–89% AD) followed by HO1-EQP acid, a dechlorinated hydroxylated analog of EQP acid (3–10% AD) and HO-EQP, a hydroxylated analog of EQP

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	(0–4% AD). Unchanged EQP was not detectable. Primary metabolites in urine and feces were EQP acid, two dechlorinated hydroxylated analogs of EQP (HO1 and HO2) and smaller amounts of the hydroxylated analog of EQP (HO). These metabolites accounted for 64–93% of the AD. **Excretion**: Fairly rapid excretion was noted with half-lives of 48 hrs (♂) and 60 hrs (♀). The amount of radioactivity in urine compared to the amount in the feces was similar in ♀s; however, in ♂s more than 4.5 times more radioactivity was found in the feces than in urine. Total excreted radioactivity was 88% AD (♂) and 95% AD (♀). Total recoveries from excreta (urine and feces), organs, tissues and cage washings were 98.5% AD (♂) and 92% AD (♀).
Absorption, Distribution, Metabolism and Excretion (low oral dose with pre-conditioning: repeat dose)(dietary and gavage) Quizalofop-ethyl Charles River CD rat PMRA# 1224185	Unlabelled EQP at 100 ppm in the feed for 21 days, followed by a single oral gavage dose (Quinoxaline - ^{14}C EQP), labelled in the phenyl portion of the quinoxalinyl ring, diluted with unlabelled EQP, in ethanol: corn oil (1:9) at **16 mg/kg bw** (2 mL/kg bw) **Distribution**: Organ and tissue retention of radioactivity was low, with highest concentrations in the ♂s in the liver (0.91 ppm), GI tract (0.89 ppm) and kidney (0.84 ppm), and in the ♀s in the kidney (0.62 ppm) and hide (0.49 ppm). Lowest levels (0.01–0.02 ppm) were found in the brain of both sexes. **Metabolism**: The distribution of metabolites in the organs and tissues showed that DPX-Y6202 acid was in the highest concentration (17–91% AD) followed by dechlorinated hydroxylated analogs HO1-EQP acid (03–4.8% AD) and HO-EQP acid (0–27.4% AD). Unchanged EQP was not detectable. Major metabolites in urine and feces were EQP acid and the two dechlorinated hydroxylated analogs of EQP (HO1 and HO2) which in total accounted for 70–86% of the AD. **Excretion**: Fairly rapid excretion was noted with half-lives of 46 hrs (♂) and 42 hrs (♀). The amount of radioactivity in urine compared to the amount in the feces was similar in ♀s; however, in ♂s more than twice the amount of radioactivity was found in the feces than was found in the urine. Total excreted radioactivity was 84% AD (♂) and 90.5% AD (♀). Total recoveries from excreta (urine and feces), organs, tissues and cage washings were greater than 91% AD in both sexes.
Absorption, Distribution, Metabolism and Excretion	Quinoxaline - ^{14}C-EQP, labelled in the phenyl portion of the quinoxalinyl ring, diluted with unlabelled EQP in ethanol: corn oil at **200 mg/kg bw** (3 mL/kg bw)

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(single high dose) (gavage) Quizalofop-ethyl Charles River CD rat PMRA# 1224185	**Distribution**: Organ and tissues contained high levels of radioactivity. In ♂s, greatest concentrations were in the skin (51.5 ppm), gonads (33 ppm), and hide (28 ppm). In ♀s, greatest concentrations were in the gonads (10 ppm), hide (9.5 ppm), and bones (9 ppm). The lowest level in both sexes was in the brain (0.2–0.5 ppm). **Metabolism**: Metabolites in the organs and tissues included, EQP acid (4.6–39.2% AD, lowest levels occurring the fat), HO-EQP (6–22% AD), and HO1-EQP acid (2.8–24.6% AD). Unchanged EQP was identified in the fat (21% AD) and in the GI tract (0.6% AD). Primary metabolites in urine and feces were EQP acid (31–67.5% AD), two dechlorinated hydroxylated analogs of EQP (HO1 and HO2; (11.5–14% AD and 8–22% AD, respectively) and the hydroxylated analog of EQP (HO; 14.9% AD). These metabolites accounted for 59–87% of the AD. **Excretion**: Fairly rapid excretion with half of the dosed radioactivity excreted within 48 hrs. The amount of radioactivity in urine compared to the amount in the feces was 1:2.5 in ♂s and 1:4 in ♀s. Total excreted radioactivity was 91% AD (♂) and 103% AD (♀). Total recoveries from excreta (urine and feces), organs, tissues and cage washings were 96% AD (♂) and 106% AD (♀).
Absorption, Distribution, Metabolism and Excretion (single high dose) (gavage) Quizalofop-ethyl Charles River CD rat PMRA# 1224185	Phenyl -^{14}C EQP, diluted with unlabelled EQP, in ethanol: corn oil at **200 mg/kg bw** (3 mL/kg bw) **Distribution**: Relatively high levels of radioactivity were retained in organs and tissues: in the kidneys, skin and bones of the ♂s; and in the hide, kidney, and spleen and GI tract of the ♀s. **Metabolism**: The three primary metabolites identified in the urine and feces were EQP acid, HO1-EQP acid and HO2-EQP acid. No radioactivity was detected as carbon dioxide or volatile metabolites in expired air. **Excretion**: Fairly rapid excretion was noted with a half-life of 76 hrs (but closer to 85 hrs when derived from graphical representation of data). The amount of radioactivity in urine compared to the amount in the feces was similar in ♂s; however, in ♀s approximately twice as much radioactivity was found in the feces versus in urine. Total excreted radioactivity was > 90% of the AD.
Absorption, Distribution, Metabolism and Excretion	1. Quinoxaline - ^{14}C EQP, labelled in the phenyl portion of the quinoxalinyl ring, diluted with unlabelled EQP, in ethanol: corn oil at **200 mg/kg bw, 700 mg/kg bw**; 2. Phenyl -^{14}C EQP, diluted with unlabelled EQP, in ethanol: corn oil at

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(single high dose)(gavage) Quizalofop-ethyl Charles River CD rat PMRA# 2719113	**200 mg/kg bw** **Metabolism**: In this amendment to the previous study (PMRA# 1224185), EQP pentanoic acid (PL-1) was identified in the liver of rats at a relatively low concentration ranging from 0.9 to 2.3% of the radioactivity in the tissue. The major metabolite was EQP-acid which was detected at concentrations of 62.8 to 69.1% of total liver radioactivity. Other metabolites included Phenol 1 (2.0–12.0%) and unknowns (10.6–14.4%). Unextracted radioactivity ranged from 10.8–20.5%.
Acute Toxicity Studies	
Acute oral toxicity Quizalofop-ethyl CD-1 mouse PMRA# 1184263, 1224167, 1224169, 1224728	**LD_{50} = 2350 mg/kg bw (♂)** **LD_{50} = 2360 mg/kg bw (♀)** **Clinical signs:** ≥1800 mg/kg bw: ↑ incidence of prone position, slow gait, weak or slow respiration, ↓ response to external stimuli, disappearance of righting reflex, no lustre of hair coat and wasting. **Low acute toxicity**
Acute oral toxicity Quizalofop-ethyl Sprague-Dawley rat PMRA# 1184262, 1224168	**LD_{50} = 1670 mg/kg bw (♂)** **LD_{50} = 1480 mg/kg bw (♀)** **Clinical Signs:** ≥833 mg/kg bw: slow gait and ruffled hair ≥1000 mg/kg bw: inactivity and prone position, within 24 hrs. Additional symptoms at 2–14 days included crouching, red tears and/or red stains around eyes, continuous prone position, weak and/or slow respiration, decrease in response to external stimulation, ruffled hair coat, disappearance of righting reflex and wasting **Slightly acutely toxic**
Acute oral toxicity Sprague-Dawley rat L-enantiomer only from of quizalofop-ethyl PMRA# 1161268	**LD_{50} = 1088 mg/kg bw (♂)** **LD_{50} = 870 mg/kg bw (♀)** **LD_{50} = 952 mg/kg bw (combined ♂/♀)** **Signs observed** (with no dose response): ↓ bw, lethargy, diarrhea, wet inguinal fur, rough coat, redness around eyes

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	Moderately acutely toxic
Acute oral toxicity Sprague-Dawley rat Quizalofop-p-ethyl PMRA# 1161273	**LD_{50} = 1209 mg/kg bw (♂)** **LD_{50} = 1182 mg/kg bw (♀)** **LD_{50} = 1203 mg/kg bw combined** (♂/♀) **Signs observed** (with no dose response): ↓ bw, lethargy, diarrhea, wet inguinal fur, rough coat, redness around eyes, tremors and hunched posture **Slightly acutely toxic**
Acute dermal toxicity Quizalofop-ethyl Sprague-Dawley rat PMRA# 1184264, 1224171	**LD_{50} > 5000 mg/kg bw (♂/♀)** No mortality or clinical signs of toxicity **Low acute toxicity**
Acute inhalation toxicity (4 hrs, assumed whole body) Quizalofop-ethyl Crl:CD® rat PMRA# 1184266, 1224172	**LC_{50} ♂ > 5.9 mg/L; ♀ > 3.4 mg/L; Combined (♂/♀) = 5.8 mg/L** **Signs:** hair loss, ruffled fur, wet and stained perineum, nasal discharge, hunched posture and pallor. In a dose-dependent manner, all exposed rats exhibited continuous slight to moderate weight loss for 2–9 days post-exposure. **Low acute toxicity**
Primary Eye Irritation Quizalofop-ethyl New Zealand White rabbit PMRA# 1224173	**MIS = 6/110 (1 hr)** **MAS = 1.67/110** Irritation scores at 1, 24, 48, and 72 hrs and 7 days were 6 (5⅓), 1⅓ (2), 1⅓ (2), ⅔ (⅔), 0 (0), respectively for unrinsed (rinsed) Irritation was limited to the conjunctivae, clearing by day 4: a diffuse, crimson red colouration of the conjunctivae was accompanied by slight

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	swelling. **Minimally irritating to the eye**
Primary Skin Irritation Quizalofop-ethyl New Zealand White rabbit PMRA# 1224174	**MIS = 0/8** **MAS = 0/8** **Non-irritating to the skin**
Dermal sensitization (Buehler method) Quizalofop-ethyl Hartley-Dunkin Guinea pig PMRA# 1224180	The challenge dose did not cause a skin reaction in any of the animals, 24 and 48 hrs after the removal of the patch **Negative**
Short-Term Toxicity Studies	
21-day dermal toxicity study Quizalofop-ethyl New Zealand White rabbit PMRA# 2719116	**Supplemental Study** Limitations: limited reporting of methods; no reporting of clinical signs, body weight, food consumption, hematology, clinical chemistry and organ weights. No compound-related effects (pathology) were detected in the rabbits following a 21-day application or following a two week recovery period.
13-wk oral toxicity study (dietary) with 4-wk recovery period at high dose Quizalofop-ethyl CD-1 mouse	NOAEL not established **LOAEL = 15/25 mg/kg bw/day** ≥ 15 mg/kg bw/day (100 ppm): ↑ rel. liver wt., histopathological changes: ↑ hypertrophy/hyperplasia, degeneration/necrosis of individual hepatocytes with DR in severity (♂/♀) ≥ 41/74 mg/kg bw/day (316 ppm): green-brown pigment, bile duct hyperplasia (no recovery at HDT at 4 wks) (♂/♀); ↑ swollen abdomens, ↑ incidence enlarged livers,↑ albumin, ↑ ALP, ↑ ALT, ↑ rel.

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PMRA# 1184249, 1224183	adrenals wt. (♂); ↑ extramedullary hematopoiesis in spleen, ↓ # corpora lutea (♀) 174/258 mg/kg bw/day (1000 ppm): ↑ swollen abdomens, ↑ incidence enlarged livers and discoloured livers, or livers with tan areas or pin prick yellow areas, ↑ rel. adrenals wt., ↑ liver necrosis (not reversible at 4 wks recovery in ♂)(♂/♀); ↓ bwg, ↑ fc, ↓ abs. testes wt., ↑ extramedullary hematopoiesis, ↑ total protein, ↑ AST, ↑ Ca, ↓ cholesterol (♂); ↓ platelet counts, ↑ rel. thyroid wt. (♀)
13-wk oral toxicity study (dietary) with 4-wk recovery period CD-1 mouse Quizalofop-p-ethyl PMRA# 1161277, 1161276	**NOAEL = 17/21 mg/kg bw/day** (♂/♀) ≥ 56/67 mg/kg bw/day (316 ppm): ↑ liver wt. (interim and terminal, restored at recovery except in high dose ♂), histopathological changes in hepatocytes: centrilobular and mid-zonal hepatocytic hypertrophy, liver necrosis (interim and terminal; mostly reversible in ♂s), ↑ mitoses in liver and bile duct hyperplasia (reversible) (♂/♀) 175/205 mg/kg bw/day (1000 ppm): ↑ pigmentation in Kupffer's cells and degenerate cells (partial recovery 5/8), ↑ terminal bile duct hyperplasia (reversing at recovery), ↑ hepatic enzyme values and serum proteins (ALT, ALP, total protein, albumin, albumin/globulin ratio, and LDH) presence of pigment (♂/♀); ↑ AST, ↓ globulin (♂) No treatment-related effects on mortality, clinical signs, bw, fc, haematological parameters or urinalysis
13-wk oral toxicity study (dietary) with 6 wk recovery period Quizalofop-ethyl CD (UK) rat of Sprague-Dawley origin PMRA# 1184250, 1224184, 1224232	**NOAEL = 8/10 mg/kg bw/day** (♂/♀) 82.9/93.6 mg/kg bw/day (1280 ppm): ↓ bwg (0–13 wks) (↑ in ♂ during recovery), ↓ fc (both sexes, ♀ - nss), liver surface pitted (partial reversal), slight/minimal centrilobular and/or mid-zonal liver cell enlargement, enlarged livers, ↑ rel. liver wt., ↓ Hb (♂/♀); ↑ rel. heart wt., ↓ rel. testes wt., ↓ rel. adrenal wt., small and flaccid testes, testicular atrophy and/or suppression of spermatogenesis, hematological effects (↓ RBC, ↑ MCV, ↑ MCH, ↓ MCHC), ↑ total protein , ↑ A/G ratio ↓ Ca (wk 4 and 12), focal inflammatory changes (♂); ↓ rel. pituitary wt.,↑ urine pH (wk 3), ↓ MCV (wk 12) (♀) After 6 wks of recovery there were no treatment-related liver changes but testicular atrophy or suppression of spermatogenesis still occurred in 3/5 males

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13-wk oral toxicity study (dietary) Sprague-Dawley rat Quizalofop-p-ethyl PMRA# 1161278	**NOAEL = 7.7/9.0 mg/kg bw/day** (♂/♀) 82.4/91.6 mg/kg bw/day (1280 ppm): ↑ liver wt. (reversed at recovery), changes in clinical chemistry values, returned to normal at recovery: ↑ ALP, ↑ albumin, ↑ A/G ratio, ↑ BUN, ↑ ChE ↓ globulin (♂/♀); ↓ bw, ↓ cholesterol, ↓ triglycerides, testicular atrophy (1 ♂ at termination, 3 ♂ at recovery-not reversible) (♂) No treatment-related effects on mortality, clinical signs, fc, hematological parameters or urinalysis
26-wk oral toxicity study (dietary) Quizalofop-ethyl Beagle dog PMRA# 1184251, 1224243	**NOAEL = 3.2/3.17 mg/kg bw/day** (♂/♀) 12.75/12.39 mg/kg bw/day (400 ppm): atrophy of the seminiferous tubules of the testis (2/6) (♂); ↑ BUN (♀)
52-week oral toxicity study (dietary) Quizalofop-ethyl Beagle dog PMRA# 1184271, 1224031, 1224163	**NOAEL = 10 mg/kg bw/day** (♂/♀) 10 mg/kg bw/day (400 ppm): ↑ rel. liver wt. (not adverse) (♂/♀)
Chronic Toxicity/Oncogenicity Studies	
18-month chronic toxicity/oncogenicity study (dietary) Quizalofop-ethyl CD-1 mouse PMRA# 1184254,	**NOAEL = 1.5 mg/kg bw/day** (♂/♀) ≥ 12 mg/kg bw/day (80 ppm): ↑ pigmentation of hepatocytes, sinusoidal cells and focal pigmented macrophages, ↑ ALP (♂/♀); bilateral testicular atrophy (♂); ↑ liver wt., ↑ kidney wt. (♀) 48 mg/kg bw/day (320 ppm): swollen abdomen, ↑ incidence of enlarged and dark liver, ↑ A/G ratio, ↑ liver wt., diffuse hepatocytic enlargement (♂/♀); ↓ survival (ss), ↑ incidence of exophthalmus (median day of onset week 52), changes in serum proteins, single incidences (52 wk) of interstitial Leydig cell hyperplasia, abnormal

Study Type/Animal/PMRA#	Study results
1222759, 1222761, 1222762, 1222764, 1222766, 1222768, 1222770, 1222772, 1222775, 1224046, 1224107, 1224151, 1224159, 1224729, 1223697	sperm forms, testes atrophy and sperm stasis, ↓ testes wt. (♂); ↑ pale kidneys (all animals), ↑ incidence granular/pitted/rough kidneys (all animals), ↑ kidney cysts, ↑ total cholesterol, ↑ ovarian cyst (52 wk)(♀) ↑ incidence of benign ovarian luteomas (nss) (♀: 0/51, 0/51, 1/46, 0/53, 3/50 (6%) slightly exceeding historical control upper range (0-5%), Granulosa cell 0/51, 0/51, 0/46, 0/53, 1/50 (2%) and 2/50 (4%) instances of luteal cell hyperplasia at the HDT (♀) ↑ hepatocellular tumours (nss) Hepatocellular adenoma (♂): 3/50 (6%), 4/49 (8%), 5/51 (10%), 6/52 (12%), 8/51 (16%); Total (including all surviving satellite animals killed on wk 26 (n=10) and 52 (n=10), in addition to all surviving at week 78 (n=50): 3/70 (4%), 6/69 (9%), 5/69 (7%), 8/70 (11%). Hepatocellular carcinoma (♂): 4/50 (8%), 4/49 (8%), 2/51(4%), 1/52 (2%), 10/51 (20%); Total (including all surviving satellite animals killed on wk 26 (n=10) and 52 (n=10), in addition to all surviving at week 78 (n=50): 4/70 (6%), 4/69 (6%), 2/69 (3%), 1/69 (1%), 10/70 (14%) Combined hepatocellular adenoma and carcinoma (♂) (positive trend): 7/50 (14%), 8/49 (16%), 6/51 (12%), 7/52 (14%), 15*/51 (29%); Total (including all surviving satellite animals killed on wk 26 (n=10) and 52 (n=10), in addition to all surviving at week 78 (n=50)): 7/70 (10%), 10/69 (14%), 7/69 (10%), 8/69 (11%), 15*/70 (21%)) Luteoma HC (♀): Set 1 (78 weeks) Hazleton Labs range 0–0%; individual HC studies: 0/98 (0%), 0/51(0%), 0/45 (5%); total 0/194 (0%) Granulosa theca cell tumour HC: range (0–1%); individual HC studies: 1/98 (1%), 0/51, 0/45, 1/194 (0.5%); total: 1/194 (0.5%) Set 2 (91–105 weeks) Hazleton Labs (Positive control) Luteoma HC Total 10 studies 0/293 Granulosa theca cell tumour HC: range (0–15%); individual HC studies: 0/1/29 (3.4%), 4/26 (15.4%), 1/27 (3.7%); total: 6/293 (2%) Set 3 (78 weeks) Haskell Labs (registrant provided, more recent studies using the same source of mice) Luteoma HC range (0-5%); individual studies: 0/73, 3/80 (4%), 4/76 (5%), 1/80 (1%), total 8/309 (3%) Granulosa theca cell tumour HC:

Study Type/Animal/PMRA#	Study results
	range (0–1%); individual HC studies: 0/73, 0/80, 1/76 (1%), 0/80; total 1/309 (0.3%) Set 4 (same source of mice; recent publication from Charles River with no further detail) Luteoma HC Total: 0–2%); total 2/486 (0.4%) Granulosa theca cell tumour HC range (0-2%); individual HC studies: 1/487 (0.2%) **Hepatocellular HC set #1** (more robust Supplementary studies, Hazleton Labs) Range from 10 studies (91–105 weeks duration) hepatocellular adenomas: ♂: 0–16% (mean 6.3%), ♀: 0–6% hepatocellular carcinomas ♂: 6–28% (mean 14.4%), ♀: 0–12% **Hepatocellular HC set #2** range from 3 studies (78 weeks duration, Hazleton labs) Adenomas: 8–18% Carcinomas: 3–7% The benign ovarian tumours were deemed unrelated to treatment because the incidence at the high dose did not reach statistical significance to concurrent negative control values, and it fell just above the upper range noted in the more recent historical control set that used the same source of animals. **Evidence of carcinogenicity (liver tumours)**
24 month chronic toxicity/carcinogenicity study (dietary) Quizalofop-ethyl Sprague-Dawley rat PMRA# 1184253, 1184272, 1222751, 1222755, 1222757, 1223781, 1224007,	**NOAEL = 0.9/1.1 mg/kg bw/day** (♂/♀) ≥ 3.7/4.6 mg/kg bw/day (100 ppm): ↑ thyroid wt., changes in serum proteins (↑ albumin (wk 12, 26, 52 - ♀ only this week), ↓ globulin (wk 12, 26), ↑ A/G ratio, changes in ions (↑ Na, Ca, P, Cl), fluctuations in haematology parameters (↓ PCV, ↓ Hb, ↓ RBC, variable effects on MCHC and MCV with tendency for ↓), ↑ liver wt, ↑ hepatocellular enlargement (♂/♀); ↑ incidence of dark areas of liver (wk 78 and terminal kill) (♀) 15.5/18.6 mg/kg bw/day (400 ppm): ↑ kidney wt. (wk 105), ↑ incidence of cytoplasmic eosinophilia in liver, slight ↑ incidence of dilated/congested sinusoids, ↑ plasma ChE (♂/♀); ↓ bw, ↑ incidence of dark areas of liver (terminal kill), ↑ALP (consistent throughout treatment approximately twofold)(♂); ↓ heart wt (wk 105 ss)(♀) ↑ incidence (nss) of liver cell tumours was observed in the HDT ♀s

Study Type/Animal/PMRA#	Study results
1224020, 1224034, 1224036, 1224038 1223697	(adenomas: 3/86, 1/83, 1/83, 1/83; carcinomas: 0/86, 0/83, 2/83, 4/83 (5%) (one ♀ with multiple tumours) when compared to both the concurrent and HC incidences (♀ range of carcinomas: 0–2%, range for adenomas: 0–2%). Carcinomas were generally observed at the end of the study. Combined incidence of adenomas and carcinomas: 3/86, 1/83, 3/83, 5/83 (no DR). HC Studies: Hepatocellular carcinomas: ♂: 0/50, 1/50, 1/55, 1/50, 1/50, 1/50 (range 0–2% in 6 studies) ♀: 0/50, 0/55, 0/50, 0/50, 0/50, 1/51 (range 0–2% in 6 studies) Hepatocellular adenomas : ♂: 0/50, 0/50, 1/50, 1/50, 1/50, 2/55 (range 0–4% in 6 studies) ♀: 0/50, 0/51, 0/50, 1/55, 1/50, 1/50 (range 0–2% in 6 studies) **No evidence of tumorigenicity**
Developmental/reproductive toxicity studies	
2-generation reproductive toxicity (dietary) Quizalofop-ethyl Sprague-Dawley rat PMRA# 1224110, 1224148	**Parental NOAEL = 9.4/10.2 mg/kg bw/day (100 ppm) (♂/♀)** 37.8/42.1 mg/kg bw/day: F0 ♂: ↓ bw (days 63, 70, 84, 91), ↓ bwg (days 0–70) $F1_a$ ♂: ↓ bwg (days 0–14) $F1_a$ ♀: ↓ bwg (days 0–7 premating) **Offspring NOAEL = 2.6 mg/kg bw/day (25 ppm)** $F1_b$ and $F2_a$ F_{2b} exposed in utero (sacrificed PND 21) ≥10.2 mg/kg bw/day (100 ppm): ↑ liver wt. (weanlings: F_{2b}), liver pathology: ↑ eosinophilic granular cytoplasm in the hepatocytes and ↓ cytoplasmic basophilia and glycogen accumulation (F_{2b}10/10) 37.8 mg/kg bw/day (400 ppm): ↓ pup bw ss (PND 0-21, $F1_a$ and 1_b, PND 7-21 $F2_a$), PND 4-21 ($F2_b$), ↓ spleen wt. ($F2_b$) (♂/♀); ↓ thymus wt. ($F2_b$), ↓ lung wt. ($F2_b$), ↑ rel. heart wt. ($F2_b$), ↓ abs. testes wt. ($F2_b$) (♂) **Reproductive NOAEL = 37.8/42.1 mg/kg bw/day (400 ppm) (♂/♀)** 37.8/42.1 mg/kg bw/day (400 ppm): ↓ pup bw (F1a, b on PND 0) In ♀s, no treatment related effects were observed in the fertility index, gestation index, 0–4 day viability, lactation index or on litter survival. In ♂s there was no biologically significant treatment-related effect on fertility at any dose level. No sperm parameters were measured

Study Type/Animal/PMRA#	Study results
	Evidence of sensitivity of the young
Modified developmental toxicity (gavage) Dosed GD 6-15 Quizalofop-ethyl Sprague-Dawley rat PMRA# 1184255, 1224265, 1224736	Two sets of animals were used per treatment group. One group was sacrificed on gestational day (GD) 21, and a smaller group was retained as a nursing group set (culled on PND 4 to 4/sex/litter). General differentiation such as incisor budding, separation of eyelids, testes descent and vaginal opening were recorded in the nursing set, as well as functional tests (walking, spontaneous movement, postures, variety of reflexes, open field test and learning test via water labyrinth method). Reproductive ability was tested in F1 animals from the nursing group (2/sex from each litter; with animals paired at 10 wks of age for 10 days to assess ability to induce pregnancy, with further breeding added as necessary for assessing any unsuccessfully mated rats). **Maternal NOAEL = 100 mg/kg bw/day** 300 mg/kg bw/day: ↓ bwg (GD 6-16), ↓ fc, ↑ incidence of retained placenta **Developmental NOAEL = 100 mg/kg bw/day** 300 mg/kg bw/day: ↑ pancreas wt, ↑ incidence of foetal skeletal variations/dams: ↑ incidence of accelerated ossification corpus of cervical vertebra and diaphysis of metatarsus (#1), delayed ossification in the arcus of the 3rd coccygeal vertebra and delayed ossification of digitus menus phalanx proximalis (#1 and 5), delayed ossification of digitus pedis phalanx proximalis (#2–5), ↑ 14th rib (predominantly small) **Nursing subgroup:** 300 mg/kg bw/day; offspring (8 wks of age): ↓ bw (PND 4 to 5-8 wks), ↓ fc (from 4–8 wks) ↓ rel. kidney wt., preputial separation was not measured, vaginal patency was not affected (♂/♀); ↑ abs. liver wt., slight ↑ abs. pancreas wt (♂); ↓ uterus wt. (♀) No effects were noted in this study on reproduction in dams, offspring functionality including learning ability, or skeletal development in offspring (8 wks of age) **Learning Test**: no effect on time needed to complete swim maze on 3 trials at 5–6 wks of age **Reproduction:** No treatment-related effects Sperm parameters were not measured.

Study Type/Animal/PMRA#	Study results
	No evidence of sensitivity of the young or treatment-related malformations
Range-finding developmental toxicity (gavage) Quizalofop-ethyl Dosed GD 7-19 New Zealand White rabbit PMRA# 1222553	**Supplemental- range finding** Maternal: ≥25 mg/kg bw/day: ↓ bwg and or bw loss (GD 7-29) ≥60 mg/kg bw/day: ↑ abortions (0/6, 0/6, 0/6, 1/6, 3/6) 75 mg/kg bw/day: ↓ bw (GD 29), ↓ fc, clear jelly-like anal discharge, ↑ soft feces, ↓ number of live foetuses/litter Developmental: 75 mg/kg bw/day: ↓ number of live foetuses/litter (driven by abortions)
Developmental toxicity (gavage) Dosed GD 7-19 Quizalofop-ethyl New Zealand White rabbit PMRA# 1222554	**Maternal NOAEL = 60 mg/kg bw/day** No treatment-related effects. **Developmental NOAEL = 60 mg/kg bw/day** No treatment-related effects. **No evidence of sensitivity of the young or treatment-related malformations**
Developmental toxicity (gavage) Dosed GD 7-18 Quizalofop-ethyl New Zealand White rabbit PMRA# 1224266, 1224737	**Maternal NOAEL = 60 mg/kg bw/day** No treatment-related effects **Developmental NOAEL = 60 mg/kg bw/day** No treatment-related effects **No evidence of sensitivity of the young or treatment-related malformations**
Genotoxicity Studies	
Rec- assay / Bacterial Reverse Mutation Assay (in vitro) B. subtilis, strains M45	Rec$^{+/-}$-assay – **negative (+/- metabolic activation) up to 2500 µg/plate** Ames test – **negative (+/- metabolic activation) up to 2500 µg/plate**

Study Type/Animal/PMRA#	Study results
rec$^-$ and H17 rec$^+$ (for DNA damaging ability); E. coli WP^2 hcr$^-$; S. typhimurium TA98, TA100, TA1535, TA1537, TA1538 Quizalofop-ethyl PMRA# 1184256, 1224268	
Bacterial Reverse Mutation Assay (in vitro) S. typhimurium TA98, TA100, TA1535, TA 1537, TA 1538 ± S-9. Quizalofop-p-ethyl PMRA# 1161247	**Negative (+/-metabolic activation) up to 5000 µg/plate**
Micronucleus test CD-1 mouse Quizalofop-ethyl PMRA# 1184261, 1224269	**Negative** up to 1200 mg/kg bw
Unscheduled DNA synthesis Rat hepatocyte cells Quizalofop-ethyl PMRA# 1184260, 1224270	**Negative** up to 6 mM

Study Type/Animal/PMRA#	Study results
Unscheduled DNA synthesis Rat hepatocyte cells Quizalofop-p-ethyl PMRA# 1161250, 1161251	**Negative** up to 1000 µg/mL
In vitro chromosome aberration test Chinese hamster lung fibroblast cell line (CHL) Quizalofop-ethyl PMRA# 1184259, 1224233	**Negative** up to 500 µg /mL Cytotoxicity noted at 500 µg/mL with activation.
CHO/HGPRT gene mutation assay BH4 clone of the CHO-K1 cell line Quizalofop-ethyl PMRA# 1184258, 1224234	**Negative** up to 1 mM The test material began to precipitate out at ≥ 0.25 mM and so 1.0 mM was the highest level tested. Slightly more toxicity with activation (about 10% more). Positive controls produced strong mutagenicity
Mouse lymphoma forward mutation assay 5178Y/TK$^{+/-}$ mouse lymphoma cells Quizalofop-p-ethyl PMRA# 1161248, 1161249	**Negative** up to 500 or 1000 µg/mL, **(+/- metabolic activation)**, respectively

Study Type/Animal/PMRA#	Study results
Immunotoxicity Studies	
28-day oral immunotoxicity study (Enzyme-linked immunosorbent assay) (dietary) CD-1 mouse Quizalofop-p-ethyl PMRA# 2717605, 2719119	**NOAEL = 55 mg/kg bw/day** 103 mg/kg bw/day (600 ppm): liver effects [enlarged (4/10), focal tan discolouration (1/10)] There were no compound-related effects on mortality, clinical signs, body weight, food consumption, organ weights, gross pathology, histopathology, or immunotoxicity. No evidence of immune system dysregulation.
Special Studies (non-guideline)	
Liver enzyme induction study Sprague-Dawley rat Quizalofop-ethyl PMRA# 1224725	≥20 mg/kg bw/day (400 ppm): ↑ rel. liver wt. (♂/♀); ↑ DNA conc. (♀) 64 mg/kg bw/day (1280 ppm): ↓ bwg (♂); ↑ microsomal protein concentration in liver, ↓ rel. DNA concentration (µg DNA /g liver wt.) (♀) No apparent dose-related trends observed in cytochrome P450 or b5 **Phenobarbital** 50 mg/kg bw/day: ↓ bwg, ↑ cytochrome P450 and b5, ↑ microsomal protein concentration in liver (♂/♀); ↑ rel. liver wt. (♀)
Liver enzyme induction study ♂ Balb/c mouse Quizalofop-ethyl PMRA# 1224724	≥48 mg/kg bw/day (320 ppm): ↑ rel. liver wt. (↑ cytochrome b5 levels, ↑ microsomal protein concentration in liver 150 mg/kg bw/day (1000 ppm): ↓ cytochrome P450 levels All NC-302 treated groups and the control mice had significantly lower cytochrome P450 and b5 levels compared to the phenobarbital-treated mice. **Phenobarbital** 50 mg/kg bw/day: ↓ bwg, ↑ cytochrome P450 and b5, ↑ microsomal protein concentration in liver
Liver enzyme induction study ♀ Balb/c mouse	≥48 mg/kg bw/day (320 ppm): ↑ rel. liver wt., ↓ cytochrome P450 levels, ↑ microsomal protein concentration in liver

Study Type/Animal/PMRA#	Study results
Quizalofop-ethyl PMRA# 1224722	All EQP treated groups and the control mice had significantly lower cytochrome P450 and b5 levels compared to the phenobarbital-treated mice. **Phenobarbital** 50 mg/kg bw/day: ↑ cytochrome P450 and b5, ↑ microsomal protein concentration in liver
Effect on the mixed function oxidase system ♂ CD-1 mouse Quizalofop-ethyl PMRA# 1224726	100 mg/kg bw/day: ↑ rel. liver wt, ↓ cytochrome b5 levels, ↑ microsomal protein concentration in liver, ↓ aldrin epoxidase and 7-ethoxy-coumarin de-ethylase, ↑ lauric acid hydroxylase **Phenobarbital** 80 mg/kg bw/day: ↑ rel. liver wt., ↑ cytochrome P450 (x2), ↑ aldrin epoxidase and 7-ethoxy-coumarin de-ethylase
Peroxisome proliferation in the liver (gavage) ♂ CD-1 mouse Quizalofop-ethyl PMRA# 1224726	**Supplemental** Limitation: protocol issues including the lack of adequate characterization of morphological characteristics, no definition of "normal" limits, and no attempt to demonstrate a possible DR relationship. Enzyme activities associated with peroxisome proliferation activity were not investigated. Characteristic differences between sex or interspecies sensitivities were not studied. 100 mg/kg bw/day: ↑ rel. liver wt. The authors state that the test material was shown to significantly increase the number of peroxisomes present in the liver confirming that the compound is a clofibrate-type peroxisome proliferator; however the study had several limitations.

Appendix IV Dietary exposure and risk assessments

Table 1 Chronic dietary risk assessment for Quizalofop-p-ethyl

Summary of Chronic Non-Cancer Dietary Risk for Quizalofop-p-ethyl[3]		
Population subgroup	Food only	Food and drinking water[2]
	% ADI[1] (Basic)	% ADI[1] (Basic)
General Population	13.9	15.0
All Infants (<1 year old)	29.6	33.9
Children 1–2 years old	**51.2**	**52.7**
Children 3–5 years old	38.3	39.6
Children 6–12 years old	22.8	23.7
Youth 13–19 years old	13.0	13.8
Adults 20–49 years old	10.2	11.4
Adults 50+ years old	9.0	10.1
Females 13–49 years old	10.2	11.3

[1] Acceptable Daily Intake (ADI) of 0.01 mg/kg body weight/day applies to the general population and all population subgroups. Bolded values indicate population group with the highest exposures.
[2] Level 1 EEC in groundwater: 5.6 µg a.i./L
[3] The established United States tolerances for Crop Group 11-09 (Pome Fruits), Crop Group 12-09 (Stone Fruits) and Crop Subgroup 13-07F (Small Fruits Vine Climbing, except Fuzzy Kiwifruit) were included in the DEA. The Canadian MRLs for these crops, which are consistent with the established American tolerances, are under promulgation as a result of review under URMULE program.

Appendix V Food residue chemistry summary

Quizalofop-p-ethyl is a selective postemergence herbicide belonging to the aryloxyphenoxypropionate chemical family. The initial registration of quizalofop-p-ethyl was largely based on data on file for quizalofop-ethyl, a 50:50 racemic mixture. Quizalofop-p-ethyl is the resolved D(+) isomer of quizalofop-ethyl.

In Canada, quizalofop-p-ethyl is registered for agricultural use on a wide variety of crops. The end-use products are formulated as emulsifiable concentrates. The maximum seasonal application rates range from 36.5–72 g a.i./ha.

The nature of the residue in plant and animal commodities is adequately understood. The residue definition in all plant and animal commodities for risk assessment and enforcement is quizalofop-ethyl (ethyl (RS) 2-[4-(6-chloroquinoxalin-2-yloxy)phenoxy]propionate), including the acid metabolites of (RS)2-[4-(6-chloroquinoxalin-2-yloxy)phenoxy] propanoic acid, all expressed as quizalofop-ethyl. Residues of the resolved isomer quizalofop-p-ethyl are covered by MRLs for quizalofop-ethyl, the unresolved isomeric mixture. There are no changes in residue definition proposed for these commodities. The residue definition for risk assessment in drinking water is being revised from quizalofop-p-ethyl and quizalofop-acid only to quizalofop-p-ethyl + quizalofop-p + hydroxy-quizalofop + dihydroxy-quinoxaline + hydroxy-quinoxaline with this re-evaluation.

Maximum Residue Limits (MRLs) have been established for residues of quizalofop-ethyl and its metabolites and published in Health Canada's List of MRLs Regulated under the *Pest Control Products Act* on the Maximum Residue Limits for Pesticides webpage. It is noted that the use expansion request under User Requested Minor Use Label Expansion (URMULE) program was jointly reviewed with the United States Environmental Protection Agency (USEPA) and the MRLs are proposed for Crop Group 11-09 (Pome Fruits), Crop Group 12-09 (Stone Fruits) and Crop Subgroup 13-07F (Small Fruits Vine Climbing, except Fuzzy Kiwifruit). At this time, the United States established the tolerances that are consistent with the proposed Canadian MRLs, but the MRLs are under promulgation in Canada. The DEA reported herein was conducted using the updated American tolerances.

Several analytical methods for quizalofop-ethyl and quizalofop-p-ethyl have been reviewed previously and were deemed acceptable for data collection in plant and animal commodities and enforcement in plant commodities. Since adequate methods are on file for the determination of residues of quizalofop-ethyl and its acid metabolites in animal commodities, the lack of an enforcement method for animal commodities will not be identified as a deficiency for the current re-evaluation. Quantitation of residues is performed by high performance liquid chromatography with UV detection (HPLC/UV), gas chromatography with mass selective detection (GC/MS), and HPLC with electrochemical detection.

Sufficient information was available to assess the dietary exposure and risk from exposure to quizalofop-p-ethyl and its metabolites. Residue field trial data were reviewed for the registered uses of quizalofop-p-ethyl and were determined to be adequate to support the current use patterns.

Appendix VI Mixer/loader and applicator exposure and risk assessment

Table 1 Mixer/loader/applicators using groundboom equipment

Crop	Representative use	M/L UE (µg/kg a.i.)		Applicator UE (µg kg a.i.)		Maximum AR[a] (kg a.i./ha)	ATPD[b] (ha)	Daily exposure (mg/kg bw/day)		MOE		
		Dermal	Inhalation	Dermal	Inhalation			Dermal	Inhalation	Dermal	Inhalation	Combined[f]
Open mix/load liquids and open cab groundboom liquid application (AHETF); PPE: coveralls, chemical-resistant gloves												
Large field crops	Seed Alfalfa	31.32	0.63	14.19	1.68	0.072	360	0.0074	0.00075	351	3467	319
Vegetables and fruits	Saskatoon Berries	31.32	0.63	14.19	1.68	0.072	26	0.0005	0.00005	5200	52,000	4727

M/L = mixer/loader; UE = unit exposure; AR = application rate; ATPD = area treated per day; MOE = Margin of exposure; CF = Conversion factor

[a] Maximum AR (kg a.i./ha) - as per current product labels
[b] ATPD (ha) – PMRA default values
[c] Dermal exposure (mg/kg bw/day) = Dermal UE (µg/kg a.i.) × CF (1 mg/1000 µg) × ATPD (ha) × Maximum AR (kg a.i./ha) × 50% dermal absorption / average worker body weight (80 kg)
[d] Inhalation exposure (mg/kg bw/day) = Inhalation UE (µg/kg a.i.) × CF (1 mg/1000 µg) × ATPD (ha) × Maximum AR (kg a.i./ha) / average worker body weight (80 kg)
[e] Based on a dermal and inhalation NOAEL of 2.6 mg/kg bw/day; target MOE of 100 (Appendix III)
[f] Combined MOE = 1/((1/MOE dermal) + (1/MOE inhalation))

Table 2 Mixer/loader and applicators using aerial equipment

Representative use	M/L UE (µg/kg a.i.)		M/L UE (µg/kg a.i.)		Maximum AR[a] (kg a.i./ha)	ATPD[b] (ha)	Daily exposure (mg/kg bw/day)		MOE [e]		
	Dermal	Inhalation	Dermal	Inhalation			Dermal [c]	Inhalation [d]	Dermal	Inhalation	Combined [f]
Open mix/load Liquids (AHETF); PPE: coveralls, chemical-resistant gloves											
Seed Alfalfa	31.32	0.63	-	-	0.072	400	0.0056	0.000227	464	11464	446
Closed Cockpit Aerial Liquid Application (AHETF); PPE: coveralls, chemical-resistant gloves*											
Seed Alfalfa	-	-	2.18	0.00969	0.072	400	0.0004	0.000003	6500	>100,000	6452

M/L = mixer/loader; UE = unit exposure; AR = application rate; ATPD = area treated per day; MOE = Margin of Exposure; CF = Conversion factor
*For closed cab/cockpit scenarios, chemical resistant gloves were only worn to perform activities outside of the cab/cockpit.

[a] Maximum AR (kg a.i./ha) - as per current product labels
[b] ATPD (ha) – PMRA default values
[c] Dermal exposure (mg/kg bw/day) = Dermal UE (µg/kg a.i.) × CF (1 mg/1000 µg) × ATPD (ha) × Maximum AR (kg a.i./ha) × 50% dermal absorption / average worker body weight (80 kg)
[d] Inhalation exposure (mg/kg bw/day) = Inhalation UE (µg/kg a.i.) × CF (1 mg/1000 µg) × ATPD (ha) × Maximum AR (kg a.i./ha) / average worker body weight (80 kg)
[e] Based on a dermal and inhalation NOAEL of 2.6 mg/kg bw/day; target MOE of 100 (Appendix III)
[f] Combined MOE: = 1/((1/MOE dermal) + (1/MOE inhalation))

Appendix VII Occupational postapplication exposure and risk assessment

Crop	Use directions[a] AR (g a.i./ha) (Number of applications)	Peak DFR[b] (µg a.i./cm^2)	Activity	TC[c] (cm^2/hr)	Dermal Exposure[d] (mg/kg bw/day)	MOE[e]	REI (hours)
Seed alfalfa; Established red and alsike clovers for seed production only; Seedling or established creeping red fescue for seed production only: Seedling legumes for seed production (for bird's-foot trefoil, alsike, red, white and sweet clover and sainfoin); Industrial hemp grown for fibre, seed and oil; Rutabagas; Chickpeas; Field and seed corn; Lentils; Dry beans; Dry common beans; Peas (field and processing); Snap beans; Narrow leaf lupin; Cucurbit Vegetables; Saskatoon Berry; Crop, subgroup 13-07F (Small fruits vine climbing, except fuzzy Kiwifruit);	72 (1×)	0.18	Irrigation (hand set)	1750	0.0158	165	12
Canola; Crambe ; Flax (including low linolenic acid varieties); Yellow, and brown mustard; Oriental mustard (including canola quality Brassica juncea) (condiment and oilseed type); Soybeans;			Scouting	1100	0.0099	263	
Sunflowers Tribenuron-methyl toleranct sunflowers			Scouting	90	0.0008	3210	
Crop, subgroup 13-07F (Small fruits vine climbing, except fuzzy Kiwifruit)			Scouting/ Weeding, Hand	640	0.0058	451	
Crop group 1-09 (Pome Fruit); and 12-09 (Stone Fruit)			Scouting	580	0.0052	498	
Ethiopian mustard (Brassica carinata);	48 (1×)	0.12	Scouting	1100	0.0066	394	
Sugarbeets	72 (1×)	0.18	Scouting	210	0.0019	1376	
	36 (2×, RTI 14 days)	0.11	Scouting	210	0.0012	2239	
Camelina sativa	72 (1×, REI of 4 days)	0.12	Scouting	1100	0.0065	400	4 (days)

AR = application rate; RTI = re-treatment interval; DFR = dislodgeable foliar residue; TC = transfer coefficient
MOE = margin of exposure; REI = restricted-entry interval; CF = conversion factor

[a] Use directions as per current product labels
[b] Peak DFR (µg a.i./cm^2) – calculated assuming 25% of application rate with a 10% residue dissipation per day
[c] TC (cm^2/hr) – values from the Agricultural Re-entry Task Force (ARTF) database
[d] Dermal Exposure (mg/kg bw/day) = TC (cm^2/hr) × DFR (µg a.i./cm^2) × CF (1 mg/1000 µg) × 50% dermal absorption × 8 hours/day / average worker body weight (80 kg)
[e] Based on a NOAEL of 2.6 mg/kg bw/day, target MOE of 100 (Appendix III)

Appendix VIII Environmental assessment

Table 1 Quizalofop-p-ethyl and its major transformation products

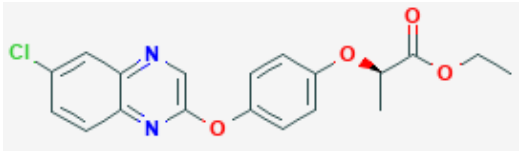
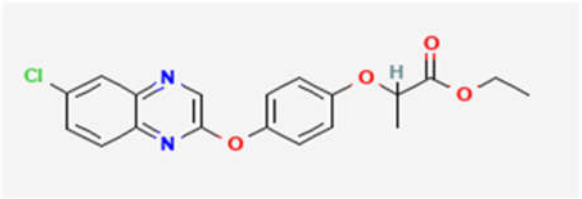
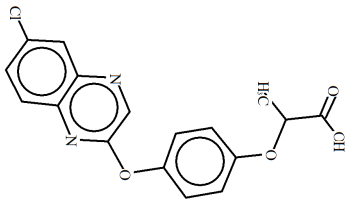
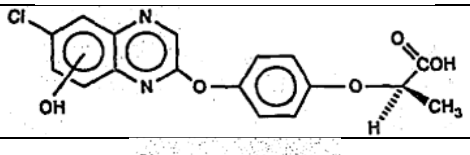
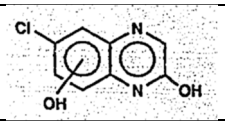
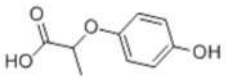
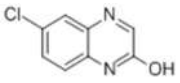
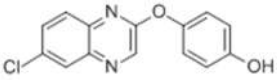
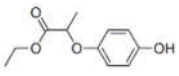
Substance name	Structure
Quizalofop-p-ethyl (parent: currently registered active ingredient; R(+) enantiomer)	
Quizalofop-ethyl (previously registered active ingredient; 50/50 racemic mixture of R(+) and S(-) enantiomers)	
Quizalofop-acid	
Hydroxy-quizalofop	
Dihydroxy-quinoxaline	
2-(4-hydroxyphenoxy)-propanoic acid	
Hydroxy-quinoxaline	
Quizalofop-phenol	
Ethyl phenoxy acid	
CO_2	

Table 2 Summary of fate and behaviour of quizalofop-p-ethyl in the environment

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
Abiotic transformation					
Hydrolysis	Quizalofop-ethyl	**25°C** pH 5 = stable pH 7 = 29.4 d pH 9 = 0.93 d	Quizalofop-acid (pH 7: 43.4%; pH 9: 99%)	Not a major route of transformation	1224238
	Quizalofop-ethyl	**25°C; sterilized buffer** pH 2 = 7 – 14 d pH 5 and 7 = 80% AR remained after 30 d pH 9 < 1 d	pH 7 and 9, Quizalofop-acid (21.1 % AR at day 30, pH 7 and 76.4 % AR at day 14, pH 9)	Not a major route of transformation	3281018
	Quizalofop-p-ethyl (purity: 99.6%)	**50°C** pH 4 = >1 year pH 7 = 3.7 pH 9 < 2.4 hours **40°C** pH 7 = 10.7 **25°C** pH 7 = 59.8	Hydrolysis products were not identified for this study.	Not a major route of transformation under environmentally relevant conditions. Stable under acidic conditions; unstable under alkaline conditions (high temperatures).	3281018
	Quizalofop-acid	pH 5, 7 and 9 = stable	NA	Not a major route of transformation	3281018
Phototransformation on Soil	Quizalofop-ethyl	**(Combined labels) Woodstown Sandy Loam:** DT_{50} = 51.5 Tr = 1 830	Quizalofop-acid (7.2%), CO_2 (22%)	Not a major route of transformation	1224112

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
	Quizalofop-ethyl	**(Quinoxaline label) Woodstown Sandy Loam:** DT_{50} << 1 Tr = 3.86 **Flanagan Silt Loam:** DT_{50} << 1 Tr = 3.26	Quizalofop-acid (75%), Quizalofop-Phenol (11%), Dihydroxy-quinoxaline (6%)	The study was not conducted under sterile conditions resulting in the dark controls degrading almost as fast as the irradiated samples.	1224189
	Quizalofop-ethyl	–IORE DT_{50} = 54 IORE DT_{90} = 11 120 IORE Tr = 3 348	Quizalofop-acid (7.2% AR; irradiated conditions, day 15), CO_2 (22.3% AR)	Not a major route of transformation	3281018
Phototransformation in Water	Quizalofop-ethyl	**Continuous Light:** DT_{50} = 62.5 to 72.7	QP (4%) Phenol 1 (5%) Phenol 2 (3%) CO_2 (9%)	Not a major route of transformation	1224113
	Quizalofop-p-ethyl	**Continuous Light:** DT_{50} = 38.3 DT_{90} = 127	CO_2	Not a major route of transformation	3281018
Volatilization	Quizalofop-p-ethyl	Vapour pressure: 1.1 × 10^{-7} Pa (8.3 × 10^{-10} mmHg)	NA	Low volatility	1479092
	Quizalofop-p-ethyl	No volatilization observed from plant surface in 24h	Not assessed	Low volatility	3281018
	Quizalofop-p-ethyl	Less than 0.3% volatilized in 24h from sandy soil	Not assessed	Low volatility	3281018

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
Biotransformation in soil					
Biotransformation in aerobic soil	Quizalofop-ethyl	**Woodstown Sandy Loam (0.1 ppm):** IORE DT_{50}: 1.99 IORE Tr: 16.5 **(1 ppm):** DFOP DT_{50}: 1.65 DFOP Tr: 94.8 **Flanagan silt Loam (0.1 ppm):** IORE DT_{50}: 1.99 IORE Tr: 55.3 **(1 ppm):** IORE DT_{50}: 0.599 IORE Tr: 18.4	Quizalofop-acid (87%, wk 3; the predominant TP in all treatments and sampling times), Quizalofop-phenol (6.8%), Hydroxy-quinoxaline (3.3%)	Non-persistent Study results were compiled after 16.5 weeks. Complete study, up to 50 weeks of sampling, reported in PMRA# 1224013. Bound residues were determined in full study.	1224241

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
	Quizalofop-ethyl	**Woodstown Sandy Loam (0.1 ppm):** IORE DT_{50}: 1.32 IORE Tr: 21.6 **(1 ppm):** IORE DT_{50}: 0.5 IORE Tr: 120 **Flanagan silt Loam (0.1 ppm):** IORE DT_{50}: 2.26 IORE Tr: 48.2 **(1 ppm):** IORE DT_{50}: 0.346 IORE Tr: 21.4	Quizalofop-acid (90%; wk 16.5; the predominant TP in all treatments and all sampling times) Quizalofop-phenol (5%), Hydroxy-quinoxaline (7%), Dihydroxy-quinoxaline (43%) CO_2 (6%)	Non-persistent Bound residues ranged from 12 to 25 % AR at week 50, the end of the study.	1224013

Study type	Test material	DT_{50}/$t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMR A#
	Quizalofop-ethyl	**Woodstown Sandy Loam (0.1 ppm):** IORE DT_{50}: < 0.1 IORE Tr: 33.7 **(1 ppm):** IORE DT_{50}: < 0.1 IORE Tr: 2.41 **Flanagan silt Loam (0.1 ppm):** IORE DT_{50}: < 0.1 IORE Tr: < 0.1 **(1 ppm):** IORE DT_{50}: < 0.1 IORE Tr: 0.04	Quizalofop-acid (78%), Quizalofop-phenol (6%), Ethyl phenoxy acid (2%), 2-(4-hydroxy phenoxy)-propanoic acid (31.1 %), CO_2 (38%)	Non-persistent TPs quizalofop-acid and 2-(4-hydroxy phenoxy)-propanoic acid reach maximum levels by weeks 3 to 5 and then decline to <12 % AR by study termination (53 weeks). Bound radioactivity gradually increases to 19 to 38 % AR by week 53.	12240 14
	Quizalofop-ethyl	**Silty Loam:** IORE DT_{50}: 0.9 IORE Tr: 17	Quizalofop acid (36 % AR, 15 d), Quizalofop-phenol (4.3%), Ethyl phenoxy acid (1.2%), 2-(4-hydroxy phenoxy)-propanoic acid (6.4%), Quizalofop-ethyl acetate (1.8%), CO_2 (3%)	Non-persistent Unextracted radioactivity accounted for 39% AR by day 30.	12240 12

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
	Quizalofop-ethyl	**Chiba Silty Loam:** IORE DT_{50}: 0.9 IORE Tr: 18.6 **Nagano Light Clay:** IORE DT_{50}: 0.48 IORE Tr: 5.02	Quizalofop-ethyl (36%), Quizalofop-phenol (4.3%), Ethyl phenoxy acid (1.6%), 2-(4-hydroxy phenoxy)-propanoic acid (7%), CO_2 (0.8%)	Non-persistent	1224010
	Quizalofop-p-ethyl (radiochemical purity >99 %)	DFOP DT_{50}: 2.76 DFOP Tr: 65.7 (f=0.654; χ^2=0.8)	Quizalofop-acid (63%, 15 d), Hydroxy-quizalofop (21%, day 30 and 60), Quizalofop-phenol (2.3%), Hydroxy-quinoxaline (5%), Dihydroxy-quinoxaline (11%), CO_2 (8%)	Non-persistent Quizalofop-acid was the dominant TP throughout the 91-day study, declining to 17 % AR by study termination. Bound residues increased to 23 to 27% AR by 91 days, study termination.	1164020

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
	Quizalofop-p-ethyl (radiochemical purity 99.5%)	**UK Sandy Loam** IORE DT_{50} = 0.5 IORE DT_{90} = 15 IORE Tr = 4	Quizalofop-acid (67.0% AR, day 7), Hydroxy-quizalofop (13.5% AR, d 184), Dihydroxy-quinoxaline (12.3% AR, day 184)	Non-persistent Quizalofop-acid declined to 38.5% AR on day 184. Bound residues were 23% AR after 184 days (mainly associated with humin fraction).	3281018
	Quizalofop-ethyl (racemate) / Quizalofop-P-ethyl (R(+(enantiomer) and Quizalofop-ethyl (S(-) enantiomer) (radiochemical purity >99%)	**UK Sandy Loam** Quizalofop-ethyl: IORE DT_{50} < 0.1 IORE DT_{90} = 1.5 IORE Tr = 0.4 Quizalofop-P-ethyl: IORE DT_{50} < 0.1 IORE DT_{90} = 1.6 IORE Tr = 0.5	Quizalofop-acid (84% AR, day 1), Hydroxyl-quizalofop (13.9% AR, day 60),	Non-persistent Quizalofop-acid peaked on day 1 and steadily declined to ≤12.4% by 120 days). All three forms of quizalofop transformed similarly.	3281018

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMR A#
	Quizalofop-p-ethyl (R(+(enantiomer) (radiochemical purity 99.7%)	**UK Silty Clay Loam:** IORE DT_{50} = 0.1 IORE DT_{90} = 3 IORE Tr = 0.9 **UK Clay Loam:** IORE DT_{50} < 0.1 IORE DT_{90} = 1.2 IORE Tr = 0.4	Quizalofop-acid (80% AR) Quizalofop phenol (3% AR) Hydroxy-quizalofop (15.7% AR) Phenoxy-acid (3.6% AR)	Non-persistent Quizalofop-acid peaked on day 1 and steadily declined to 6.4% by 153 days). Bound residues were 37.9% after 153 days.	3281018
	Quizalofop-p-ethyl (R(+(enantiomer) (radiochemical purity >97%) and Quizalofop-ethyl (racemate) / (radiochemical purity >97%)	**UK Abington Sandy Loam:** EQP: IORE DT_{50} < 0.1 IORE DT_{90} = 1.2 IORE Tr = 0.4 **QPE:** IORE DT_{50} < 0.1 IORE DT_{90} = 0.6 IORE Tr = 0.2	Quizalofop-acid (85% AR) Quizalofop phenol (4.8% AR) Hydroxy-quizalofop (3.3% AR) CO2 (18.6% AR)	Non-persistent Quizalofop-acid peaked between days 1 and 3 before declining to 49.6 (quizalofop-ethyl) and 20.0% (quizalofop-p-ethyl) by day 100. Bound residues were 32% (quizalofop-ethyl) and 48% (quizalofop-p-ethyl) after 100 days.	3281018

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMR A#
	Quizalofop-p-ethyl (R(+(enantiomer) (radiochemical purity 99.25%)	**UK Sandy Loam:** IORE DT_{50} = 0.2 IORE DT_{90} = 8 IORE Tr = 2.4	Quizalofop-acid (76% AR) Hydroxy-quizalofop (11% AR)	Non-persistent Quizalofop-acid peaked on day 7 before declining to 26.7% by day 120.	3281018
	6-Chloro-3-hydroxy quinoxaline-2-one (dihydroxy-quinoxaline) (purity 98.8%)	**UK Clay:** SFO DT_{50} = 102 SFO DT_{90} = 338 **UK Sandy Loam:** SFO DT_{50} = 53 SFO DT_{90} = 175 **UK Silty Clay Loam:** SFO DT_{50} = 42 SFO DT_{90} = 140	Not assessed	Slightly to moderately persistent	3281018

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
	Quizalofop-p-ethyl	**ErlenBach Loamy Sand** FOMC DT_{50} = 21 **Münchenbuchsee Sandy Loam** DFOP DT_{50} = 0.22 **Müntschemier Sandy Loam** FOMC DT_{50} = 0.21 Crushed sand (loamy sand) FOMC DT_{50} = 0.69	Quizalofop-acid (98–100%)	Non persistent to slightly persistent	3280462
	Quizalofop-acid	**ErlenBach Loamy Sand** FOMC DT_{50} = 96 **Münchenbuchsee Sandy Loam** DFOP DT_{50} = 113 **Müntschemier Sandy Loam** FOMC ST50 > 1000 **Crushed sand (loamy sand)** FOMC DT_{50} = 371	None detected	Moderately persistent to Persistent	3280462

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMR A#
	Hydroxy-quizalofop	**ErlenBach Loamy Sand** SFO DT_{50} = 37 **Münchenbuchsee Sandy Loam** SFO DT_{50} = 35 **Müntschemier Sandy Loam** SFO DT_{50} = 630 **Crushed sand (loamy sand)** SFO DT_{50} = 189	Dihydroxy-quinoxaline (29%)	Slightly persistent to Persistent	3280462
	Dihydroxy-quinoxaline	**ErlenBach Loamy Sand** FOMC DT_{50} = 335 **Münchenbuchsee Sandy Loam** FOMC DT_{50} = 24 **Müntschemier Sandy Loam** SFO DT_{50} = 445 **Crushed sand (loamy sand)** FOMC DT_{50} = 474	None detected	Slightly persistent to persistent	3280462

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
	Quizalofop-p-ethyl	**Sichuan Dazhou Sandy Loam** 0.7; 1 **Henan Xinxiang Sandy Loam** 0.2; 0.3 **Jiangxi Nanchang Clay** 6.6 d, 8.7 d	Not assessed	Non-persistent	3280480
Biotransformation in anaerobic Soil	Quizalofop-ethyl	**Silty Loam:** DFOP DT_{50}: 1.08 DFOP Tr: 8.69	Quizalofop-acid (35% AR, 30 d), Quizalofop-phenol (1.7%), Ethyl phenoxy acid (1.2%), 2-(4-hydroxy phenoxy-propanoic acid (3%), Quizalofop-ethyl acetate (1.5%), CO_2 (0.9%)	Non-persistent Unextracted radioacitivity accounted for 45% AR by day 30.	1224012
	Quizalofop-ethyl	**Chiba Silty Loam:** IORE DT_{50}: 1.2 IORE Tr: 12.9	Quizalofop-acid (35% AR, day 30), CO_2 (1.1% AR)	Non-persistent	1224010

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMR A#
	Quizalofop-P-ethyl (R(+) enantiomer) (radiochemical purity 97.49%) and Quizalofop-ethyl (S(-) enantiomer) (radiochemical purity 97.77%)	**UK Sandy Loam:** DT_{50} < 1 **Quizalofop-acid:** DT_{50} = 253 d, persistent.; DT_{90} = 880 d	Quizalofop-acid (92.7%), 2-(4-hydroxy phenoxy) propanoic acid (7.7%)	Non-persistent Quizalofop-acid peaked on day 7 before declining to 71.0% on day 120. (DT50 = 253 d	3281018
Mobility					
Property	**Test material**	**Mean K_d/K_{oc} (L/kg)**	**Comment**	**Mobility classification**	**PMR A#**
Adsorption in soil	Quizalofop--ethyl	Kd = 50 K_{oc} = 1816	Four soils	Low to slight mobility	1224010
	Quizalofop-ethyl	Kd = 17 K_{oc} = 1 309	Four soils	Low mobility	1222566
	Quizalofop-acid	Kd = 20 K_{oc} = 476	Four soils	Low to moderate mobility	1224010
	Quizalofop-acid	Kd = 15 K_{oc} = 293	Four soils	Low to moderate mobility	1224081
	Quizalofop-acid	Kd = 38 K_{oc} = 1015	Four soils	Low to moderate mobility	3281018
	Hydroxy-quizalofop	Kd = 42 K_{oc} = 666	Three soils	Low to high mobility	3281018
	Dihydroxy-quioxaline	Kd = 13 K_{oc} = 371		Low to very high mobility	3281018
	Quizalofop-p-ethyl	Kd = 30 K_{oc} = 18124	Four soils	Slight mobility to immobile	3280462
	Quizalofop-acid	Kd = 2 K_{oc} = 1451	Four soils	Slight to moderate mobility	3280462
	Hydroxy-quizalofop	Kd = 1 K_{oc} = 813	Four soils	Low to moderate mobility	3280462

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
	Dihydroxy-quinoxaline	*K*d = 1 K_{oc} = 946	Four soils	Low mobility	3280462
Soil leaching	Quizalofop-ethyl	(Four soils) **Eluate** 0.2–26.8% AR Quizalofop-ethyl (0%); QP (95-97%); quizalofop phenol (1.3%) **Soil** 70.1–96.2% AR First two inches (~ 5 cm): Quizalofop-ethyl (7–58.5% AR); Quizalofop-acid (23.2–75.3% AR); quizalofop phenol (0–3.9% AR); hydroxy-quinozaline (0–4.4% AR) Two to twelve inches (5 cm to 30 cm): Quizalofop-ethyl (0–17.5% AR); Quizalofop-acid (58.8–82.1% AR); quizalofop phenol (0% AR); hydroxy-quinozaline (0–6.8% AR)		Moderate mobility	1224190
Lysimeter	Quizalofop-ethyl	Two soils Quizalofop-acid (84% AR) and quizalofop phenol (6.4%) detected Majority of radioactivity was in the top 10 cm soil layer. Some radioactivity down to 30 cm. No residue detectable in leachate			3281018
Field dissipation					
Test site	**Test material**	**DT_{50} (days)**	**Transformation products (Maximum % AR)**	**Classification/ comments**	**PMRA#**
Iona, ON	Assure EC (96.8 g a.i./L, Quizalofop-p-ethyl). Applied at 500 g a.i./ha	22.8	Quizalofop-acid (2.4 ppm)	Non-persitent to slightly persistent. **500 g a.i./ha:** Residues detected	1146595
Hanley, SK		6.1			
Beaumont, AB		4.8			
Iona, ON	Assure EC	4.7			

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
Hanley, SK	(96.8 g a.i./L, Quizalofop-p-ethyl). Applied at 5000 g a.i./ha	14.3		down to 10 cm **5000 g a.i./ha:** Residues detected down to 30 cm	
Beaumont, AB		18.0			
Illinois	Assure EC (95.8 g a.i./L, Quizalofop-p-ethyl)	156	Dihydroxy-quinoxaline (0.07 ppm)	Non-persitent to persistent. DT50s based on quizalofop-ethyl + Quizalofop-acid residues	1223769
California		364			
North Carolina		4.9			
Mississippi		138			
Illinois (silt loam)	^{14}C-Quizalofop-ethyl (99.4 to 99.9% purity). Applied at 280 g a.i./ha.	DFOP DT_{50} = 1.9d DFOP DT_{90} = 6.7d DFOP Tr = 2039d	Quizalofop-acid (66%), Quizalofop phenol (6.6%) Hydroxy-quinoxaline (3.3%) Ethyl-phenoxy-acid (2.3%) 2-(4-hydroyphenoxy)propionic acid (9.6%) Dihydroxy-quinoxaline (27.4%)	Non-persitent to slightly persistent. **Illinois, Mississippi, Delaware:** Residues detected down to 4" **North Carolina:** Residues detected down to 8".	1224047
North Carolina (Loamy sand)		IORE DT_{50} = 0.19d IORE DT_{90} = 4.8d IORE Tr = 1.4d			
Mississippi (Silt loam)		DFOP DT_{50} = 1.5d DFOP DT_{90} = 5.2d DFOP Tr = 967d			
DelawareE (Silt loam)		IORE DT_{50} = 0.02d IORE DT_{90} = 4.5 d IORE Tr = 1.3d			

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMR A#
UK (Lawford Silty sand or Loamy Sand),	Targa Prestige EC (50 g a.i./L, Quizalofop-p-ethyl). Applied at 200 g a.i./ha	Quizalofop-p-ethyl: DT_{50} = 1.75 DT_{90} = 5.83 Quizalofop-acid: DT_{50} = 14.9 DT_{90} = 49.4 Hydroxy-quizalofop: DT_{50} = 49.4 DT90 = 164	Quizalofop-acid (60 ppb) Hydroxy-quizalofop (5.4 ppb)	Quizalofop-p-ethyl: Non-persistent. Quizalofop-acid: Slightly persistent Hydroxy-quizalofop: Slightly to moderately persistentResidues detected in the 0–10 cm soil profile	3281018
Spain (Robledino de la Valduerna Silty Loam Sand)		Quizalofop-p-ethyl: DT_{50} = 8.2 DT_{90} = 27.4 Quizalofop-acid: DT_{50} = 37.6 DT_{90} = 125 Hydroxy-quizalofop: DT_{50} = 42.8 DT_{90} = 142.3			
Germany (Lentzke Loamy sand)		Quizalofop-p-ethyl: DT_{50} = 1.16 DT_{90} = 3.84 Quizalofop-acid: DT_{50} = 39.8 DT_{90} = 132.1 Hydroxy-quizalofop: DT_{50} = 32.2 DT_{90} = 107.2			

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
France (Moncrabeau Silty Clay Loam)		Quizalofop-p-ethyl: DT_{50} = 0.55 DT_{90} = 1.82 Quizalofop-acid: DT_{50} = 33.6 DT_{90} = 111.5 Hydroxy-quizalofop: DT_{50} = 34.5 DT_{90} = 114.7			
Biotransformation in aquatic environment					
Test site	**Test material**	**DT_{50} (days)**	**Transformation products (Maximum % AR)**	**Classification/ comments**	**PMRA#**
Aerobic Water	Quizalofop-ethyl at 25°C	DT_{50} = 0.1	Quizalofop-acid (109%) Hydroxy-quizalofop (23%) Hydroxyl-quinozaline (33%) Dihydroxy-quinoxaline (2%) CO_2 (51%)	Non-persistent	1161428
	Quizalofop-ethyl at 5°C	DT_{50} = 0.2	Quizalofop-acid (108%) Ethyl-phenoxy-acid (12%)		

Study type	Test material	$DT_{50}/t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
Aerobic Water/sediment	Quizalofop-p-acid at 10°C	**Iron Hatch Stream Total System (sand)** Quizalofop-p-ethyl: DT_{50} = 1.9 DT_{90} = 6.3 Quizalofop-acid: DT_{50} = 88.2 DT_{90} = 144 **Mill Stream Pond Total System (silty clay loam)** Quizalofop-p-ethyl: DT_{50} = 1.2 DT_{90} = 3.9 Quizalofop-acid: DT_{50} = 119 DT_{90} = 181	Quizalofop-acid (98% AR) Hydroxy-quizalofop (3.1% AR) Quizalofop-phenol (5.5% AR) 2-(4-hydroxyphenoxy)propionic acid (2.6% AR)	QPE: Non-persistent QP: Moderately persistent	3281018
Anaerobic Water/Sediment	Quizalofop-ethyl	Bradenton, Florida: IORE DT_{50} < 0.1 IORE DT_{90} = 0.7 IORE Tr = 0.2 Landenberg, Pennsylvania: IORE DT_{50} < 0.1 IORE DT_{90} < 0.1 IORE Tr < 0.1	**Quizalofop-acid (80% AR)** **Dihydroxy-quinoxaline (25.4% AR)** **Hydroxyl-quinoxaline (13.2% AR)** **2-(4-hydroxyphenoxy)propionic acid (55.1% AR)** **Quizalofop-phenol (9.5% AR)**	Non-persistent	1224015

Study type	Test material	DT_{50}/$t_{1/2\text{-}rep}$ (days)[1]	Transformation products (Maximum % AR[2])	Comments/ classification	PMRA#
Bioconcentration					
Bioconcentration	Quizalofop-ethyl/Quizalofop-p-ethyl	Log K_{ow} = 4.61 (suggests potential for bioaccumulation)			2568984 1164019
	Quizalofop-ethyl	Whole fish BCF: 290 at 0.004 mg/L 380 at 0.04 mg/L After 14-day depuration phase, > 99% residue eliminated from the 28-d whole body levels.			3281018 1224250

[1]DT_{50}s and Tr were calculated by PMRA.
[2]Percent of applied radioactivity.

Table 3 Estimated environmental concentrations/exposures

Environmental matrix	Application rate (g a.i./ha)[1]	Half-life (d)	Estimated environmental exposure (EEC[2]/EDE[3]/EER[4]/ED[5])	Notes
Soil	72	90th upper percentile of the mean of the aerobic soil representative half-life: 99.58	EEC: 0.032 g a.i./kg soil	Assumes evenly distributed in the top 0–15 cm of soil with bulk density of 1.5 g/cm^3 Used in the earthworm risk assessment.
Soil surfaces	72	90th upper percentile of the mean of the aerobic soil representative half-life: 99.58	EER: 72 g a.i/ha	Used for the terrestrial plant seedling emergence risk assessment
Plant surfaces	72	Foliar half-life: 10	EER: 72 g a.i./ha	Used for the terrestrial plant vegetative vigour and foliar dwelling beneficial arthropods risk assessment.
Contact for bees	72	Not applicable	ED: 0.173 µg a.i./bee	Conversion factor of 2.4 µg a.i./bee/day per kg a.i./ha

Environmental matrix	Application rate (g a.i./ha)[1]	Half-life (d)	Estimated environmental exposure (EEC[2]/EDE[3]/EER[4]/ED[5])	Notes
Adult bee diet	72	Not applicable	ED: 2.06 µg a.i./bee/day	Conversion factor of 28.6 µg a.i./bee/day per kg a.i./ha
Bee larvae diet	72	Not applicable	EDE[6]: 0.875 µg a.i./bee/day	Conversion factor of 12 µg a.i./bee/day per kg a.i./ha
Diet of small birds: insects (BW = 20 g)	72	Foliar half-life: 10	EDE: 5.84 mg a.i./kg bw/day	FIR = 5.1 g dw diet/day
Diet of medium birds: insects (BW = 100 g)	72	Foliar half-life: 10	EDE: 4.58 mg a.i./kg bw/ day	FIR = 19.9 g dw diet/day
Diet of large birds: short grass (BW = 1000 g)	72	Foliar half-life: 10	EDE: 2.96 mg a.i./kg bw/ day	FIR = 58.1 g dw diet/day
Diet of small mammals: insects (BW = 15 g)	72	Foliar half-life: 10	EDE: 3.34 mg a.i./kg bw/ day	FIR = 2.2 g dw diet/day
Diet of medium mammals: short grass (BW = 35 g)	72	Foliar half-life: 10	EDE: 6.35 mg a.i./kg bw/ day	FIR = 4.5 g dw diet/day
Diet of large mammals: short grass (BW = 1000 g)	72	Foliar half-life: 10	EDE: 3.49 mg a.i./kg bw/ day	FIR = 68.7 g dw diet/day
Water	72	Aerobic water/sediment whole system half-life: 0.3	EEC: 80 cm depth: 0.009 mg a.i./L EEC: 15 cm depth: 0.048 mg a.i./L	Assumes instantaneous and homogeneous mixing. 15 cm EEC used for amphibians 80 cm EEC used for all other aquatic organisms

[1]Application rate used in the risk assessment was the maximum single application rate.
[2]EEC = Estimated environmental concentration (mg a.i./kg or mg a.i./L) in soil or water

Environmental matrix	Application rate (g a.i./ha)[1]	Half-life (d)	Estimated environmental exposure (EEC[2]/EDE[3]/EER[4]/ED[5])	Notes

[3]EDE = Estimated Daily Exposure (mg a.i./kg bw/day) for birds and mammals, specialized feeding guilds are considered for each category of animal weight to help determine exposure (herbivore, frugivore, insectivore and granivore). At the screening level, relevant food items representing the most conservative EDE for each feeding guild are used (in other words, insects and small grasses). The EDE is calculated using the following formula: (FIR/BW) × EEC, where: BW = Body weight, FIR = Food ingestion rate: For generic birds with body weight less than or equal to 200 g, the "passerine" equation was used; for generic birds with body weight greater than 200 g, the "all birds" equation was used Passerine Equation: FIR (g dry weight/day) = 0.398(BW in g)$^{0.850}$. All birds Equation: FIR (g dry weight/day) = 0.648(BW in g)$^{0.651}$. For mammals, the "all mammals" equation was used: FIR (g dry weight/day) = 0.235(BW in g)$^{0.822}$
[4]EER = Estimated environmental rate (g a.i./ha)
[5]ED = Estimated dose (µg a.i./bee) for bees is calculated by converting the maximum single application rate (44 g a.i./ha) by the conversion factor listed in the table.
[6]EDE = Estimated Daily Exposure (µg a.i./larvae/day) for bee larvae is calculated by converting the maximum single application rate (44 g a.i./ha) by the conversion factor listed in the table

Table 4 Summary of toxicity effects of quizalofop-p-ethyl and its major transformation products on terrestrial organisms

Organism	Test material	Exposure	Endpoint value	Effects/ Degree of toxicity[1]	PMRA#
Invertebrates					
Earthworm *(Eisenia fetida)*	Quizalofop-p-ethyl	14-d acute adult	14-d LC_{50} > 1000 mg a.i./kg dry soil	No treatment related effects	3281017
	Quizalofop-acid	14-d acute adult	14-d LC_{50} = 948 mg/kg dry soil	Treatment related effects in the highest test concentration	3281017
	Quizalofop-acid	28-d chronic	28-d NOEC = 50.0 mg/kg dry soil (maximum test concentration)	NA	3281017
	Hydroxyl-quizalofop	14-d acute adult	14-d LC_{50} > 1000 mg/kg dry soil	Practically non-toxic	3281017
	Dihydroxy-quinoxaline	14-d acute adult	14-d LC_{50} > 1000 mg/kg dry soil	Practically non-toxic	3281017
	EXP30650 (49.4 g/L, Quizalofop-p-ethyl)	14-d acute adult	14-d LC_{50} = 746 mg/kg dry soil	Practically non-toxic	3281017

Organism	Test material	Exposure	Endpoint value	Effects/ Degree of toxicity[1]	PMRA#
	Quizalofop-ethyl	72-h acute (paper contact screening test)	72-h LC_{50} = 108.5 µg a.i./cm^2	NA	3080480
	Quizalofop-p-ethyl	72-h acute (paper contact screening test)	72-h LC_{50} = 412.4 µg a.i./cm^2	NA	3080480
	Quizalofop-acid	72-h acute (paper contact screening test)	72-h LC_{50} = 30.9 µg/cm^2	NA	3080480
Honeybee *(Apis mellifera)*	Quizalofop-p-ethyl	48-h acute oral 48-h acute contact	48-h oral LD_{50} > 103 µg/bee 48-h contact LC_{50} > 100 µg/bee	Relatively non-toxic. No treatment related effects were observed.	3258161
		48-h acute oral 48-h acute contact	48-h oral LD_{50} > 103 µg/bee 48-h contact LC_{50} > 100 µg/bee	Relatively non-toxic. No treatment related effects were observed.	3281017
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h acute oral	48-h oral LD_{50} = 10.4 µg a.i./bee (206 µg product/bee)	Relatively non-toxic. Some mortality observed in the three highest test concentrations.	3281017
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h acute contact	48-h contact LC_{50} > 25 µg a.i./bee (> 493 µg product/bee)	Relatively non-toxic. Some mortality observed in the highest test concentration.	3281017

Organism	Test material	Exposure	Endpoint value	Effects/ Degree of toxicity[1]	PMRA#
	5% EC formulation, Quizalofop-p-ethyl (end-use product)	72-h acute oral 72-h acute contact	72-h oral LD_{50} = 18.6 µg/bee 72-h contact LC_{50} = 56.9 µg/bee	Relatively non-toxic. Some mortality observed in all treatment and control groups.	3258162
	Quizalofop-p-ethyl	10-d chronic oral adult	10-d NOEDD = 39.2 µg/bee/day	NA	3258159
		10-d chronic oral adult (limit test)	10-d NOEDD = 3.59 µg/bee/day	NA	3254884
		72-h single exposure, larva	48-h LD_{50} = 16.1 µg/larva	NA	3254882
		22-d repeated exposure, larva	22-d ED_{50} > 100 µg a.i./larva 22-d NOED = 9.39 µg a.i./larva	NA	3258160
		22-d repeated exposure, larva	8-d ED_{50} = 7.51 µg a.i./larva 8-d NOED = 0.83 µg a.i./larva 22-d ED_{50} = 2.93µg a.i./larva 22-d NOED = 0.33 µg a.i./larva	NA	3254883
Parasitoid wasp *(Aphidius rhopalosiphi)*	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h acute glass plate	48-h LR_{50} = 48.5 g a.i./ha	NA	3281017
	Co-Pilot EC (100 g/L Quizalofop-p-ethyl)	48-h acute glass plate	48-h LR_{50} > 200 g a.i./ha	NA	3281017

Organism	Test material	Exposure	Endpoint value	Effects/ Degree of toxicity[1]	PMRA#
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A202)	48-h acute mortality and fecundity on potted barley plants	48-h LR_{50} > 200 g a.i./ha No reduction in fecundity	NA	3281017
Predatory mite (*Typhlodromus pyri*)	EC formulation, 50 g a.i./L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	7-d acute glass plate	7-d LR_{50} = 25 g a.i./ha	NA	3281017
	EXP30650B, EC (53.8 g/L Quizalofop-p-ethyl)	7-d acute glass plate	7-d LR_{50} was between 10.8 (27% mortality) and 215.2 (92% mortality) g a.i./ha	NA	3281017
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A202)	7-d acute mortality and fecundity bean leaves	7-d LR_{50} = 106.9 g a.i./ha No reduction in fecundity	NA	3281017
Green lacewing (*Crysoperla carnea*)	EXP30650B, EC (53.8 g/L Quizalofop-p-ethyl)	7-d acute glass plate	7-d LR_{50} > 215.2 g a.i./ha	NA	3281017
Predatory ground beetle (*Poecilus cupreus*)	EXP30650 (49.0 g/L Quizalofop-p-ethyl)	16-d mortality sand substrate	16-d LR_{50} > 98 g a.i./ha	NA	3281017
Predatory beetle (*Aleochara bilineata*)	EXP30650 (49.0 g/L Quizalofop-p-ethyl)	22-d reproduction; sand substrate	16-d $NOER_{50}$ > 98 g a.i./ha	NA	3281017
Birds					
Northern bobwhite quail *(Colinus virginianus)*	Quizalofop-p-ethyl	Single dose oral	14-d acute LD_{50} > 2000 mg/kg bw	Practically non-toxic	3281017
	Quizalofop-ethyl	Single dose oral	14-d acute LD_{50} > 2000 mg/kg bw	Practically non-toxic	3281017

Organism	Test material	Exposure	Endpoint value	Effects/ Degree of toxicity[1]	PMRA#
	Quizalofop-ethyl	5-day Dietary	5-d acute LD_{50} > 5000 mg/kg feed	Practically non-toxic	3281017
	Quizalofop-p-ethyl	21-week Reproduction	20-week repro NOEC = 1000 mg/kg feed or 87.6 mg/kg bw	No treatment related effects seen in all treatment levels.	3281017
Mallard *(Anas platyrhynchos)*	Quizalofop-ethyl	Single dose oral	14-d acute LD_{50} > 2000 mg/kg bw	Practically non-toxic	3281017
	Quizalofop-ethyl	5-day Dietary	5-d acute LD_{50} > 5000 mg/kg feed	Practically non-toxic	3281017
	Quizalofop-p-ethyl	20-week Reproduction	21-week repro NOEC = 500 mg/kg feed or 58.0 mg/kg bw	Treatment related effects on hatchability, hatchlings and 14-d old survivors at the highest test concentration.	3281017
Small wild mammals					
CD-1 mouse	Quizalofop-ethyl	Single dose oral (gavage)	LD_{50} = 2350 mg/kg bw (♂) LD_{50} = 2360 mg/kg bw (♀)	Practically non-toxic	1184263, 1224167, 1224169, 1224728
Sprague Dawley rat (*Rattus norvegicus domesticus*)	Quizalofop-ethyl	Single dose oral (gavage)	LD_{50} = 1670 mg/kg bw (♂) LD_{50} = 1480 mg/kg bw (♀)	Slightly toxic	1184262, 1224168
	L-anantiomer of Quizalofop-ethyl		LD_{50} = 1088 mg/kg bw (♂) LD_{50} = 870 mg/kg bw (♀) LD_{50} = 952 mg/kg bw (combined ♂/♀)	Slightly toxic	1161268
	Quizalofop-p-ethyl		LD_{50} = 1209 mg/kg bw (♂) LD_{50} = 1182 mg/kg bw (♀) LD_{50} = 1203 mg/kg bw combined (♂/♀)	Slightly toxic	1161273

Organism	Test material	Exposure	Endpoint value	Effects/ Degree of toxicity[1]	PMRA#
	Quizalofop-ethyl	2 generation reproduction	Parental NOAEL = 9.4/10.2 mg/kg bw/day (♂/♀) Offspring NOAEL = 2.6 mg/kg bw/day Reproductive NOAEL = 37.8/ 42.1 mg/kg bw/day (♂/♀)	NA	1224110, 1224148
Vascular plants					
Onion, corn, wheat, sorghum, sugar beet, soybean, pea, tomato, rape, cucumber	Quizalofop-p-ethyl	Vegetative vigour	21-d ER_{25} = 0.86 g a.i./ha (sorghum)	NA	1322640
Onion, corn, wheat, sorghum, sugar beet, soybean, pea, tomato, rape, cucumber	Quizalofop-p-ethyl	Vegetative vigour	21-d ER_{25} = 0.58 g a.i./ha (sorghum)	NA	1322641
Corn, oat, cabbage, carrot, flax, onion, cucumber, soybean, sunflower, cotton	EC formulation, 50 g/L Quizalofop-p-ethyl	Vegetative vigour	21-d ER_{25} = 5.46 g a.i./ha (corn)	NA	3281017
Oat, sorghum, carrot, cabbage, soybean, corn, onion and wheat	Quizalofop-p-ethyl	Seedling emergence	HR_5 = 53.6 g a.i./ha	Based on EC_{50} values for eight crop species	1322640, 1322641, 3181017

[1]: USEPA classification (1985), where applicable.
NA = not applicable

Table 5 Summary of toxicity effects of quizalofop-p-ethyl technical and its major transformation products on aquatic organisms

Test species	Test substance	Exposure	Endpoints	Degree of toxicity[1]/ comments	PMRA#
Freshwater invertebrates					
Water Flea *(Daphnia magna)*	Quizalofop-ethyl	48-h acute (semi-static)	48-h EC_{50} = 0.29 mg a.i./L	Highly toxic	1164022
	Quizalofop-p-ethyl	48-h acute (semi-static)	48-h EC_{50} = 0.29 mg a.i./L	Highly toxic	3281017
	Quizalofop-p-ethyl	48-h acute (static)	48-h EC_{50} > 0.79 mg a.i./L (limit test)	Highly toxic	3281017
	Quizalofop-p-ethyl	21-d chronic repro (semi-static)	21-d NOEC = 0.023 mg a.i./L (reproduction) 21-d NOEC = 0.080 mg a.i./L (immobility)	NA	3281017
	Quizalofop-acid	48-h acute (static)	48-h EC_{50} = 57.7 mg/L	Slightly toxic	3281017
	Dihydroxy-quinoxaline	48-h acute (static)	48-h EC_{50} > 9.5 mg/L	Moderately toxic	3281017
	Quizalofop-acid	21-d chronic repro (semi-static)	21-d NOEC = 0.823 mg/L	NA	3281017
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h acute (static)	48-h EC_{50} = 0.348 mg/L	Highly toxic	3281017

Test species	Test substance	Exposure	Endpoints	Degree of toxicity[1]/ comments	PMRA#
Freshwater midge *(Chironomus riparius)*	Quizalofop-acid	28-d chronic (static)	28-d EC_{50} > 35.7 mg a.i./L (emergence and development rate) 28-d NOEC = 35.7 mg a.i./L (highest test concentration tested)	Exposure through overlaying water; no adverse effects were observed	3281017
	Quizalofop-phenol	28-d chronic (static)	28-d EC_{50} > 10 mg a.i./kg dry sediment (emergence and development rate) 28-d NOEC = 10 mg a.i./kg dry sediment	Exposure through spiked sediment; no adverse effects were observed	3281017
Freshwater fish					
Rainbow Trout (*Oncorhynchus mykiss*)	Quizalofop-p-ethyl	96-h acute (semi-static)	96-h LC_{50} > 0.50 mg a.i./L	Highly toxic	1164021
		96-h acute (semi-static)	96-h LC_{50} > 0.48 mg a.i./L	Highly toxic	3281017
		96-h acute (flow-through)	96-h LC_{50} = 0.72 mg a.i./L	Highly toxic	3281017
		96-h acute (flow-through)	96-h LC_{50} = 0.388 mg a.i./L	Highly toxic	3281017
		21-d chronic (semi-static)	21-d NOEC = 0.044 mg a.i./L	NA	3281017
	Quizalofop-acid	96-h acute	96-h LC_{50} > 91.7 mg/L	Slightly toxic	3281017

Test species	Test substance	Exposure	Endpoints	Degree of toxicity[1]/ comments	PMRA#
		(semi-static)			
	Dihydroxy-quinoxaline	96-h acute (semi-static)	96-h LC_{50} > 97.2 mg/L	Slightly toxic	3281017
	Quizalofop-acid	28-d chronic (flow-through)	28-d NOEC = 46.2 mg/L	NA	3281017
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	96-h acute (static)	96-h LC_{50} > 10.0 mg a.i./L	Slightly toxic	3281017
Bluegill sunfish (*Lepomis macrochirus)*	Quizalofop-p-ethyl	96-h acute (flow-through)	96-h LC_{50} = 0.209 mg a.i./L	Highly toxic	3281017
Amphibians					
Amphibians	Quizalofop-p-ethyl	96 hour acute (static) (using bluegill sunfish data as a surrogate)	96-h LC_{50} = 0.209 mg a.i./L	NA	3281017
		21-d chronic (semi-static) (using rainbow trout data as a surrogate)	21-d NOEC = 0.044 mg a.i./L	NA	3281017

Test species	Test substance	Exposure	Endpoints	Degree of toxicity[1]/ comments	PMRA#
Freshwater plants					
Duckweed *(Lemna gibba)*	Quizalofop-p-ethyl	7-d acute (semi-static)	7-d EC_{50} > 0.610 mg a.i./L		3281017
	Quizalofop-p-ethyl	14-d chronic (static)	14-d EC_{50} > 0.0828 mg a.i./L 14-d NOEC = 0.0828 mg a.i./L	The concentrations tested should have been expanded to determine an EC_{50}	1164024
Freshwater algae					
Green algae (*Selenastrum capriconutum*)	Quizalofop-p-ethyl	72-h acute (static)	72-h EC_{50} > 9.45 mg a.i./L		1322645
	Quizalofop-p-ethyl	5-d acute (static)	5-d EC_{50} > 1.3 mg a.i./L	The concentrations tested should have been expanded to determine an EC_{50}	1164023
	Quizalofop-acid	72-h acute (static)	72 h E_bC_{50} = 54.5 mg/L 72 h E_rC_{50} > 72.5 mg/L	NA	3281017
	Dihydroxy-quinoxaline	72-h acute (static)	72 h E_bC_{50} > 102 mg/L 72 h E_rC_{50} > 102 mg/L	NA	3281017
Green algae (*Pseudokirchneriella subcapitata)*	Quizalofop-p-ethyl	72-h acute (static)	72 h E_bC_{50} = 0.021 mg a.i./L 72 h E_rC_{50} = 0.069 mg a.i./L	NA	3281017
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	72-h acute (static)	72 h E_bC_{50} = 0.060 mg/L 72 h E_rC_{50} = 0.024 mg/L	NA	3281017

Test species	Test substance	Exposure	Endpoints	Degree of toxicity[1]/ comments	PMRA#
Cyanobacteria (*Anabaena flos-aquae*)	Quizalofop-p-ethyl	5-d acute (static)	5-d EC_{50} > 1.09 mg a.i./L	NA	3281017
Marine invertebrates					
Eastern oyster (*Crassostrea virginica*)	Quizalofop-ethyl	96-h acute shell deposition (flow-through)	96-h EC_{50} = 0.59 mg/L	Highly toxic	3254887 1224142
	Quizalofop-ethyl	48-h acute embryo larva (static)	48-h EC_{50} = 0.079 mg a.i./L	Very highly toxic	3255289
Mysid shrimp (*Mysidopsis bahia*)	Quizalofop-ethyl	96-h acute (static)	96-h EC_{50} = 0.15 mg/L	Highly toxic	1224139
Marine fish					
Sheepshead minnow (*Cyprinodon variegatus*)	Quizalofop-ethyl	96-h acute (static)	96-h LC_{50} = 1.76 mg/L	Moderately toxic	3255292

NA = not applicable

Table 6 Study endpoints, uncertainty factors and levels of concern (LOC) relevant for risk assessment

Most sensitive representitive species	Test substance	Exposure	Endpoint value	Uncertainty factor applied	Effects metric	Level of concern (LOC)
Invertebrates						
Earthworm (*Eisenia fetida*)	Quizalofop-p-ethyl	14 d-LC_{50}	> 1000 mg a.i./kg dry soil	2	500 mg a.i./kg dry soil	1
	Quizalofop-acid	14 d-LC_{50}	948 mg a.i./kg dry soil	2	474 mg a.i./kg dry soil	1
	Hydroxy-quizalofop	14 d-LC_{50}	> 1000 mg a.i./kg dry soil	2	500 mg a.i./kg dry soil	1
	Dihydroxy-	14 d-LC_{50}	> 1000 mg	2	500 mg	1

Most sensitive representitive species	Test substance	Exposure	Endpoint value	Uncertainty factor applied	Effects metric	Level of concern (LOC)
	quinoxaline		a.i./kg dry soil		a.i./kg dry soil	
	Quizalofop-acid	28-d Reproduction NOAEC	50 mg a.i./kg dry soil	1	50 mg a.i./kg dry soil	1
Predatory ground beetle (*Poecilus cupreus*)	EXP30650 (49.0 g/L Quizalofop-p-ethyl)	16-d LR_{50}	> 98 g a.i./ha	1	98 g a.i./ha	1
Predatory beetle (*Aleochara bilineata*)	EXP30650 (49.0 g/L Quizalofop-p-ethyl)	16-d $NOER_{50}$	> 98 g a.i./ha	1	98 g a.i./ha	1
Honeybee *(Apis mellifera)*	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h contact adult	> 25 µg a.i./bee	1	25 µg a.i./bee	0.4
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h acute oral adult	10.4 µg a.i./bee	1	10.4 µg a.i./bee	0.4
	Quizalofop-p-ethyl	10-d diet adult NOAEDD	39.2 µg/bee/day	1	39.2 µg/bee/day	1
	Quizalofop-p-ethyl	72-h larvae LD_{50}	16.1 µg/larva	1	16.1 µg/larva	0.4
	Quizalofop-p-ethyl	22-d larvae $NOAEDD_{emergence}$	0.33 µg a.i./larva	1	0.33 µg a.i./larva	1
Parasitoid wasp *(Aphidius rhopalosiphi)*	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h LR_{50} (glass plate)	48.5 g a.i./ha	1	48.5 g a.i./ha	2

Most sensitive representitive species	Test substance	Exposure	Endpoint value	Uncertainty factor applied	Effects metric	Level of concern (LOC)
Predatory mite (*Typhlodromus pyri*)	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	7-d LR_{50} (glass plate)	25 g a.i./ha	1	25 g a.i./ha	2
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A202)	7-d LR_{50} (leaf surface)	106.9 g a.i./ha	1	106.9 g a.i./ha	2
Birds						
Mallard (*Anas platyrhynchos*)	Quizalofop-ethyl	Single dose Oral LD_{50}	> 2000 mg/kg bw	10	200 mg/kg bw	1
	Quizalofop-p-ethyl	20-w Reproduction NOAED	87.6 mg/kg bw	1	87.6 mg/kg bw	1
Northern Bobwhite quail (*Colinus virginianus)*	Quizalofop-ethyl	Single dose Oral LD_{50}	> 2000 mg/kg bw	10	200 mg/kg bw	1
	Quizalofop-p-ethyl	21-w Reproduction NOAED	58.0 mg/kg bw	1	58.0 mg/kg bw	1
Mammals						
Sprague Dawley rat (*Rattus norvegicus domesticus*)	Quizalofop-ethyl	Single dose Oral LD_{50}	952 mg/kg bw (combined sexes)	10	95.2 mg/kg bw (combined ♂/♀)	1
		2 Generation Reproductive NOAED	37.8 mg/kg bw/day	1	37.8 mg/kg bw/day	1
Vascular plants						
All species tested	Quizalofop-p-ethyl	Vegetative vigour ER_{25}	0.58 g a.i./ha	1	0.58 g a.i./ha	1
		Seedling emergence ER_5	53.6 g a.i./ha	1	53.6 g a.i./ha	1

Most sensitive representitive species	Test substance	Exposure	Endpoint value	Uncertainty factor applied	Effects metric	Level of concern (LOC)
Freshwater invertebrates						
Water flea (*Daphnia magna*)	Quizalofop-p-ethyl	48-h EC_{50}	0.29 mg a.i./L	2	0.145 mg a.i./L	1
		21-d chronic life-cycle	0.023 mg a.i./L	1	0.023 mg a.i./L	1
	Quizalofop-acid	48-h EC_{50}	57.7 mg a.i./L	2	28.85 mg a.i./L	1
	Dihydroxy-quinozaline	48-h EC_{50}	> 9.5 mg a.i./L	2	4.75 mg a.i./L	1
	Quizalofop-acid	21-d NOEC	0.823 mg a.i./L	1	0.823 mg a.i./L	1
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h EC_{50}	0.348 mg a.i./L	2	0.174 mg a.i./L	1
Midge *(Chironomus riparius)*	Quizalofop-acid	28-d NOEC	35.7 mg a.i./L	1	35.7 mg a.i./L	1
Freshwater fish						
Rainbow Trout (*Oncorhynchus mykiss*)	Quizalofop-p-ethyl	96-h LC_{50}	0.388 mg a.i./L	10	0.0388 mg a.i./L	1
	Quizalofop-p-ethyl	21-d chronic NOEC	0.044 mg a.i./L	1	0.044 mg a.i./L	1
	Quizalofop-acid	96-h LC_{50}	> 91.7 mg a.i./L	10	9.17 mg a.i./L	1
	Dihydroxy-quinoxaline	96-h LC_{50}	> 97.2 mg a.i./L	10	9.72 mg a.i./L	1
	Quizalofop-acid	28-d chronic NOEC	> 46.2 mg a.i./L	1	46.2 mg a.i./L	1
Bluegill sunfish (*Lepomis macrochirus)*	Quizalofop-p-ethyl	96-h LC_{50}	0.209 mg a.i./L	10	0.0209 mg a.i./L	1
Amphibians						
Amphibians	Quizalofop-p-ethyl	96-h LC_{50} (using bluegill sunfish data as a surrogate)	0.209 mg a.i./L	10	0.0209 mg a.i./L	1

Most sensitive representitive species	Test substance	Exposure	Endpoint value	Uncertainty factor applied	Effects metric	Level of concern (LOC)
		21-d chronic (semi-static) (using rainbow trout data as a surrogate)	21-d NOEC = 44 µg a.i./L	1	44 µg a.i./L	1
Freshwater vascular plants						
Duckweed *(Lemna gibba)*	Quizalofop-p-ethyl	7-d EC_{50}	> 0.610 mg a.i./L	2	0.305 mg a.i./L	1
		14-d chronic NOEC	0.0828 mg a.i./L	1	0.0828 mg a.i./L	1
Freshwater algae						
Green algae (*Pseudokirchneriella subcapitata)*	Quizalofop-p-ethyl	72-h E_bC_{50}	0.021 mg/L	2	0.0105 mg/L	1
Cyanobacteria (*Anabaena flos-aquae*)	Quizalofop-p-ethyl	5-d EC_{50}	> 1.09 mg/L	2	0.545 mg/L	1
Marine fish and invertebrates						
Sheepshead minnow (*Cyprinodon variegatus*)	Quizalofop-ethyl	96-h LC_{50}	= 1.76 mg a.i./L	10	0.176 mg a.i./L	1
Eastern oyster (*Crassostrea virginica*)	Quizalofop-ethyl	96-h EC_{50}	0.59 mg/L	2	0.295 mg/L	1
	Quizalofop-ethyl	48-h embryo larva EC_{50}	0.079 mg a.i./L	2	0.0395 mg/L	1

Table 7 Screening level risk quizalofop-p-ethyl, its transformation products and end-use product to terrestrial organisms: Earthworms, honey bees, Non-target arthropods and Vascular plants

Organism	Test substance	Exposure	Effects metric for risk assessment[1]	EEC[2]	RQ[3]	Level of exceeded?[4]
Invertebrates						
Earthworm (*Eisenia fetida*)	Quizalofop-p-ethyl	14 d-LC_{50}	> 500 mg a.i./kg dry soil	0.032 mg a.i./kg soil[5]	<0.01	No
	Quizalofop-acid	14 d-LC_{50}	474 mg a.i./kg dry soil	0.030 mg a.i./kg	<0.01	No

Organism	Test substance	Exposure	Effects metric for risk assessment[1]	EEC[2]	RQ[3]	Level of exceeded?[4]
				soil		
	Hydroxy-quizalofop	14 d-LC_{50}	> 500 mg a.i./kg dry soil	0.031 mg a.i./kg soil	<0.01	No
	Dihydroxy-quinoxaline	14 d-LC_{50}	> 500 mg a.i./kg dry soil	0.017 mg a.i./kg soil	<0.01	No
	Quizalofop-acid	28-d Reproduction NOAEC	50 mg a.i./kg dry soil	0.030 mg a.i./kg soil	<0.01	No
Predatory ground beetle (*Poecilus cupreus*)	EXP30650 (49.0 g/L QPE)	16-d LR_{50}	> 98 g a.i./ha	72.0 g a.i./ha[9]	<0.73	No
Predatory beetle (*Aleochara bilineata*)	EXP30650 (49.0 g/L Quizalofop-p-ethyl)	16-d $NOER_{50}$	> 98 g a.i./ha	72.0 g a.i./ha	<0.73	No
Honeybee (*Apis mellifera*)	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h contact adult	> 25 µg a.i./bee	0.173 µg a.i./bee/day[6]	<0.01	No
	EC formulation 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h acute oral adult	10.4 µg a.i./bee	2.060 µg a.i./bee[7]	0.2	No
	Quizalofop-p-ethyl	10-d diet adult NOAEDD	39.2 µg a.i./bee/day	2.060 µg a.i./bee/day	0.1	No
	Quizalofop-p-ethyl	72-h larvae LD_{50}	16.1 µg a.i./larva	0.875 µg a.i./larva/day[8]	0.1	No

Organism	Test substance	Exposure	Effects metric for risk assessment[1]	EEC[2]	RQ[3]	Level of exceeded?[4]
	Quizalofop-p-ethyl	22-d larvae NOAEDemergence	0.33 µg a.i./larva	0.875 µg a.i./larva/day	2.7	Yes
Parasitoid wasp (*Aphidius rhopalosiphi*)	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h LR_{50} (glass plate)	48.5 g a.i./ha	72.0 g a.i./ha	1.5	No
Predatory mite (*Typhlodromus pyri*)	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	7-d LR_{50} (glass plate)	25 g a.i./ha	72.0 g a.i./ha	2.9	Yes
				Off-field (ground appl., 6% drift): 4.32 g a.i./ha	0.17	No
				Off-field (aerial appl., 23% drift): 16.56 g a.i./ha	0.66	No
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A202)	7-d LR_{50} (leaf surface)	106.9 g a.i./ha	72.0 g a.i./ha	0.67	No
Vascular plants						
Vascular plant	Quizalofop-p-ethyl	Seedling emergence	HR_5 = 53.6 g a.i./ha	In-field: 72.0 g a.i./ha[10]	1.3	Yes
				Off-field	0.08	No

Organism	Test substance	Exposure	Effects metric for risk assessment[1]	EEC[2]	RQ[3]	Level of exceeded?[4]
				(ground appl., 6% drift): 4.32 g a.i./ha[11]		
				Off-field (aerial appl., 23% drift): 16.56 g a.i./ha[11]	0.31	No
		Vegetative vigour	ER_{25} = 0.58 g a.i./ha	In-field: 72.0 g a.i./ha	124	Yes
				Off-field (ground appl., 6% drift): 4.32 g a.i./ha	7.4	Yes
				Off-field (aerial appl., 23% drift): 16.56 g a.i./ha	28.6	Yes

[1]NOAEC
[2] EEC = Estimated Environmental Concentration.
[3] RQ = Risk Quotient. The RQ is calculated by dividing the EEC by the endpoint effects metric value (RQ = EEC/effects metric endpoint value)
[4] Level of concern. The RQ is compared to the level of concern.
[5] The soil EEC of 0.032 mg a.i./kg soil was calculated based on the proposed maximum application rate of 72.0 g a.i./ha and accounting for soil degradation using the 90th upper percentile on the mean of the aerobic soil representative half-lives of 99.6 days. This concentration was calculated assuming that the product is evenly distributed in the top 0 to 15 cm depth of soil with a bulk density of 1.5 g/cm^3.
[6] The contact EEC for adult bees was determined to be 0.173 µg a.i./bee, based on the single maximum application rate of 72.0 g a.i./ha proposed for use and multiplied by a conversion factor of 2.4 µg a.i./bee per kg a.i./ha in order to convert the application rate from kg a.i/ha to µg a.i./bee.
[7] The dietary EEC for adult honey bees of 2.060 µg a.i./bee/day was calculated based on the single maximum proposed application rate (72.0 g a.i./ha) multiplied by a conversion factor of 29 µg a.i./bee/day per kg a.i./ha in order to convert the application rate from kg a.i/ha to µg a.i./bee/day.
[8] The screening level dietary EEC for honey bee larvae of 0.875 µg a.i./bee/day was calculated based on the single maximum proposed application rate (72.0 g a.i./ha) multiplied by a conversion factor of 12 µg a.i./larva/day per kg a.i./ha in order to convert the application rate from kg a.i/ha to µg a.i./bee/day.
[9] The screening level plant and soil surfaces EEC of 72.0 g a.i./ha was calculated using the proposed maximum annual application rate of 72.0 g

a.i./ha and the 90th upper percentile on the mean of the aerobic soil representative half-lives of 99.58 days.
[10] When considering the effects on seedling emergence, the estimated environmental rate (EER) of 72.0 g a.i./ha was calculated based on the proposed maximum cumulative application rate of 72.0 g a.i./ha and accounting for soil degradation using the 90th upper percentile on the mean of the aerobic soil representative half-lives of 99.58 days.
[11] The further characterized EECs for off-field exposure to non-target terrestrial plants accounted for a 6% drift factor for ground application and 23% drift factor for aerial applications using an ASAE fine spray quality. When considering the effects on vegetative vigour, the estimated environmental rate (EER) of 72.0 g a.i./ha was calculated based on the proposed maximum cumulative application rate of 72.0 g a.i./ha and accounting for run-off from foliage using a foliar half-life of 10 days.

Table 8 Screening level risk assessment of quizalofop-p-ethyl for birds and mammals from consumption of contaminated food sources based on maximum nomogram residues

	Feeding guild (food item)[1]	Effects metric (mg a.i./kg bw/d)	EDE[2] (mg a.i./kg bw)	RQ[3]	Level of concern[4]
Small Bird (0.02 kg)					
Acute	Insectivore	>200	5.86	<0.03	No
Reproduction	Insectivore	58	5.86	0.10	No
Medium Sized Bird (0.1 kg)					
Acute	Insectivore	>200	4.57	<0.02	No
Reproduction	Insectivore	58	4.57	0.08	No
Large Sized Bird (1 kg)					
Acute	Herbivore (short grass)	>200	2.95	<0.01	No
Reproduction	Herbivore (short grass)	58	2.95	0.05	No
Small Mammal (0.015 kg)					
Acute	Insectivore	95.2	3.37	0.04	No
Reproduction	Insectivore	37.8	3.37	0.09	No
Medium Sized Mammal (0.035 kg)					
Acute	Herbivore (short grass)	95.2	6.54	0.07	No
Reproduction	Herbivore (short grass)	37.8	6.54	0.17	No
Large Sized Mammal (1 kg)					
Acute	Herbivore (short grass)	95.2	3.49	0.04	No
Reproduction	Herbivore (short grass)	37.8	3.49	0.09	No

[1] Specialized feeding guilds are considered for each category of animal weights to help determine exposure (herbivore and insectivore).
[2] EDE = Estimated dietary exposure. Screening level EDEs were calculated based on using maximum residues expected following applications on field crops (72.0 g a.i./ha). At the screening level, relevant food items representing the most conservative EDE for each feeding guild are used. The EDE is calculated using the following formula: (FIR/BW) × EEC, where: FIR = Food Ingestion Rate and BW = Body weight. For generic birds with body weight less than or equal to 200 g, the "passerine" equation was used; for generic birds with body weight greater than 200 g, the "all birds" equation was used: Passerine Equation (body weight < or = 200 g): FIR (g dry weight/day) = $0.398(\text{BW in g})^{0.850}$. All birds Equation (body weight > 200 g): FIR (g dry weight/day) = $0.648(\text{BW in g})^{0.651}$. For mammals, the "all mammals" equation was used: FIR (g dry weight/day) = $0.235(\text{BW in g})^{0.822}$
[3] RQ = Risk Quotient
[4] Level of concern. The RQ is compared to the level of concern.

Table 9 Screening level risk of quizalofop-p-ethyl to aquatic organisms and risk assessment for amphibians and off-field spray drift

Organism	Test substance	Exposure	Effects metric for risk assessment [1]	EEC[2]	Risk quotient [3]	Level of concern [4]
Freshwater Invertebrates						
Water flea (*Daphnia magna*)	Quizalofop-p-ethyl	48-h flow through	0.145 mg a.i./L	0.009 mg a.i./L	0.06	No
		21 day life-cycle static renewal	0.023 mg a.i./L	0.009 mg a.i./L	0.39	No
	Quizalofop-acid	48-h EC_{50}	28.85 mg a.i./L	0.008 mg a.i./L	<0.01	No
	Dihydroxy-quinoxaline	48-h EC_{50}	4.75 mg a.i./L	0.005 mg a.i./L	<0.01	No
	Quizalofop-acid	21-d NOEC	0.823 mg a.i./L	0.008 mg a.i./L	0.01	No
	EC formulation, 50 g a.i/L Quizalofop-p-ethyl (AE F132814 00 EC05 A201)	48-h acute	0.174 mg a.i./L	0.009 mg a.i./L	0.05	No
Midge (*Chironomus riparius*)	Quizalofop-acid	28-d NOEC	37.5 mg a.i./L	0.008 mg a.i./L	<0.01	No
Freshwater Fish						
Rainbow Trout (*Oncorhynchus mykiss)*	Quizalofop-p-ethyl	96-h LC_{50}	0.0388 mg a.i./L	0.009 mg a.i./L	0.23	No
		21-d chronic NOEC	0.044 mg a.i./L	0.009 mg a.i./L	0.2	No
	Quizalofop-acid	96-h LC_{50}	>9.17 mg a.i./L	0.008 mg a.i./L	<0.01	No
	Dihydroxy-quinoxaline	96-h LC_{50}	>9.72 mg a.i./L	0.005 mg a.i./L	<0.01	No

Organism	Test substance	Exposure	Effects metric for risk assessment [1]	EEC[2]	Risk quotient [3]	Level of concern [4]
	Quizalofop-acid	28-d chronic NOEC	46.2 mg a.i./L	0.008 mg a.i./L	<0.01	No
Bluegill sunfish (*Lepomis macrochirus)*	Quizalofop-p-ethyl	96-h LC_{50}	0.0209 mg a.i./L	0.009 mg a.i./L	0.43	No
Amphibians	Quizalofop-p-ethyl	96-h LC_{50} (using bluegill sunfish data as a surrogate)	0.0209 mg a.i./L	0.048 mg a.i./L	2.3	Yes
			0.0209 mg a.i./L	Off-field (ground appl., 6% drift): 0.0029 mg a.i./L	0.14	No
			0.0209 mg a.i./L	Off-field (aerial appl., 23% drift): 0.0110 mg a.i./L	0.53	No
		21-d chronic NOEC (using rainbow trout data as a surrogate)	0.044 mg a.i./L	0.048 mg a.i./L	1.1	Yes
			0.044 mg a.i./L	Off-field (ground appl., 6% drift): 0.0029 mg a.i./L	0.07	No
			0.044 mg a.i./L	Off-field	0.25	No

Organism	Test substance	Exposure	Effects metric for risk assessment [1]	EEC[2]	Risk quotient [3]	Level of concern [4]
				(aerial appl., 23% drift): 0.0110 mg a.i./L		
	Quizalofop-acid	96-h LC_{50} (using rainbow trout data as a surrogate)	>9.17 mg a.i./L	0.044 mg a.i./L	<0.01	No
		28-d chronic NOEC (using rainbow trout data as a surrogate)	46.2 mg a.i./L	0.044 mg a.i./L	<0.01	No
Freshwater vascular plants						
Duck weed (*Lemna gibba*)	Quizalofop-p-ethyl	7-d EC_{50}	>0.305 mg a.i./L	0.009 mg a.i./L	<0.03	No
		14-d chronic NOEC	0.0828 mg a.i./L	0.009 mg a.i./L	0.11	No
Freshwater Algae						
Green algae (*Pseudokirchneriella subcapitata)*	Quizalofop-p-ethyl	72-h E_bC_{50}	0.0105 mg a.i./L	0.009 mg a.i./L	0.86	No
Cyanobacteria (*Anabaena flos-aquae*)	Quizalofop-p-ethyl	5-d EC_{50}	0.545 mg a.i./L	0.009 mg a.i./L	0.02	No
Marine fish and invertebrates						
Sheepshead minnow (*Cyprinodon variegatus*)	Quizalofop-ethyl	96-h LC_{50}	0.176 mg a.i./L	0.009 mg a.i./L	0.05	No
Eastern oyster	Quizalofop-	96-h Flow-	0.295 mg	0.009	0.03	No

Organism	Test substance	Exposure	Effects metric for risk assessment [1]	EEC[2]	Risk quotient [3]	Level of concern [4]
(*Crassostrea virginica*)	ethyl	through	a.i./L	mg a.i./L		
		48-h embryo larva static	0.0395 mg a.i./L	0.009 mg a.i./L	0.23	No
Mysid shrimp (*Mysidopsis bahia*)	Quizalofop-ethyl	96-h LC_{50}	0.075 mg a.i./L	0.009 mg a.i./L	0.12	No

[1]NOAEC
[2] EEC = Estimated Environmental Concentration.
[3] RQ = Risk Quotient. The RQ is calculated by dividing the EEC by the endpoint effects metric value (RQ = EEC/effects metric endpoint value)
[4]Level of concern. The RQ is compared to the level of concern.

Table 10 Toxic substances management policy considerations-comparison to TSMP track 1 criteria for quizalofop-p-ethyl

TSMP Track 1 Criteria	TSMP Track 1 Criterion value		Active Ingredient: Quizalofop-p-ethyl	Major transformation products[1]
CEPA toxic or CEPA toxic equivalent[2]	Yes		Yes	Yes
Predominantly anthropogenic[3]	Yes		Yes	Yes
Persistence[4]:	Soil	Half-life ≥ 182 days	No (<1–21 days)	Yes (24 – > 1000 days)
	Water/Sediment Whole System	Half-life ≥ 182 days (water) ≥ 365 days (sediment)	< 2 days	N/A
	Air	Half-life ≥ 2 days or evidence of long range transport	No (AopWIN: 0.4 days)	No/Yes[5] (AopWIN: 0.3 – 2.6 days)
Bioaccumulation[6]	Log K_{ow} ≥ 5		No (4.61)	No (KOAWIN: <0 – 3.6)
	BCF ≥ 5000		No (380)	N/A
	BAF ≥ 5000		N/A	N/A
Is the chemical a TSMP Track 1 substance (all four criteria must be met)?			No, does not meet all TSMP Track 1 criteria.	No, does not meet all TSMP Track 1 criteria.
[1] Major transformation products; quizalofop-acid, hydroxyl-quizalofop, dihydroxy-quinoxaline and 2-(4-hydroxyphenoxy)propionic acid				

[2]All pesticides will be considered CEPA-toxic or CEPA toxic equivalent for the purpose of initially assessing a pesticide against the TSMP criteria. Assessment of the CEPA toxicity criteria may be refined if required (in other words, all other TSMP criteria are met).
[3] The policy considers a substance "predominantly anthropogenic" if, based on expert judgement, its concentration in the environment medium is largely due to human activity, rather than to natural sources or releases.
[4] If the pesticide and/or the transformation product(s) meet one persistence criterion identified for one media (soil, water, sediment or air) than the criterion for persistence is considered to be met.
[5]Atmospheric oxidation half-life for dihydroxy-quinoxaline was 2.6 days
[6] Field data (for example, BAFs) are preferred over laboratory data (for example, BCFs) which, in turn, are preferred over chemical properties (for example, log K_{ow}).
BCF = bioconcentration factor; BAF = bioaccumulation factor

Appendix IX Proposed label amendment for products containing quizalofop-p-ethyl

The label amendments proposed below do not include all label requirements for individual products, such as first aid statements, disposal statements, precautionary statements, and supplementary protective equipment. Information on labels of currently registered products should not be removed unless it contradicts the label statements provided below.

1.0 Label amendments for quizalofop-p-ethyl technical products

The following statements are proposed to be added under **ENVIRONMENTAL PRECAUTIONS** for all technical grade products:

TOXIC to aquatic organisms.

DO NOT discharge effluent containing this product into sewer systems, lakes, streams, ponds, estuaries, oceans or other waters.

Disposal:

Canadian manufacturers should dispose of unwanted active ingredients and containers in accordance with municipal and provincial regulations. For additional details and clean up of spills, contact the manufacturer and the provincial regulatory agency.

2.0 Label amendments for quizalofop-p-ethyl commercial end-use products

1) For all end-use products, under the section entitled **PRECAUTIONS:**

> Wear coveralls over a long-sleeved shirt, long pants, chemical-resistant gloves, socks and shoes during mixing, loading, application, clean-up and repair. Gloves are not required during application within a closed cab and/or cockpit.

2) For all end-use products, under the section entitled **PRECAUTIONS,** add the following statement unless a more restrictive REI is specified on the product label:

> DO NOT enter or allow worker entry into treated areas during the restricted-entry interval (REI) of 12 hours.

3) For all end-use products, under the section entitled **PRECAUTIONS,** add or update the following statement:

> Apply only to agricultural crops when the potential for drift to areas of human habitation and human activity, such as houses, cottages, schools and recreational areas is minimal. Take into consideration wind speed, wind direction, temperature inversions, application equipment, and sprayer settings.

4) For CAZIVA ULTRA Q, PCP no. 34282 only, add the following statement:

DO NOT apply by air.

5) For all end-use products, under the section entitled **ENVIRONMENTAL PRECAUTIONS**, add the following statements:

Toxic to aquatic organisms and non-target terrestrial plants. Observe spray buffer zones specified under DIRECTIONS FOR USE.

This product contains an active ingredient and aromatic petroleum distillates, which are toxic to aquatic organisms.

To reduce runoff from treated areas into aquatic habitats avoid application to areas with a moderate to steep slope, compacted soil, or clay.

Avoid application when heavy rain is forecast.

Contamination of aquatic areas as a result of runoff may be reduced by including a vegetative filter strip between the treated area and the edge of the water body.

As this product is not registered for the control of pests in aquatic systems, DO NOT use to control aquatic pests.

DO NOT contaminate irrigation or drinking water supplies or aquatic habitats by cleaning of equipment or disposal of wastes.

Store this product away from food or feed.

6) For all end-use products except CAZIVA ULTRA Q, PCP no. 34282, add to **DIRECTIONS FOR USE**:

Field sprayer application: DO NOT apply during periods of dead calm. Avoid application of this product when winds are gusty. DO NOT apply with spray droplets smaller than the American Society of Agricultural Engineers (ASAE S572.1) medium classification. Boom height must be 60 cm or less above the crop or ground.

Aerial application: DO NOT apply during periods of dead calm. Avoid application of this product when winds are gusty. DO NOT apply when wind speed is greater than 16 km/h at flying height at the site of application. DO NOT apply with spray droplets smaller than the American Society of Agricultural Engineers (ASAE S572.1) medium classification. Reduce drift caused by turbulent wingtip vortices. Nozzle distribution along the spray boom length MUST NOT exceed 65% of the wing- or rotorspan.

Apply only by fixed-wing or rotary aircraft equipment which has been functionally and operationally calibrated for the atmospheric conditions of the area and the application rates and conditions of this label.

Label rates, conditions and precautions are product specific. Read and understand the entire label before opening this product. Apply only at the rate recommended for aerial application on this label. Where no rate for aerial application appears for the specific use, this product cannot be applied by any type of aerial equipment.

Ensure uniform application. To avoid streaked, uneven or overlapped application, use appropriate marking devices.

Use precautions
Apply only when meteorological conditions at the treatment site allow for complete and even crop coverage. Apply only under conditions of good practice specific to aerial application as outlined in the National Aerial Pesticide Application Manual, developed by the Federal/Provincial/Territorial Committee on Pest Management and Pesticides.

Product specific precautions
Read and understand the entire label before opening this product. If you have questions, call the manufacturer at (XXX) YYY-ZZZZ or obtain technical advice from the distributor or your provincial agricultural representative. Application of this specific product must meet and/or conform to the following:

Volume: Apply the recommended rate in a minimum spray volume of 55 litres per hectare.

SPRAY BUFFER ZONES
A spray buffer zone is NOT required for:

- low-clearance hooded or shielded sprayers that prevent spray contact with crop, fruit or foliage,

The spray buffer zones specified in the table below are required between the point of direct application and the closest downwind edge of sensitive terrestrial habitats (such as grasslands, forested areas, shelter belts, woodlots, hedgerows, riparian areas and shrublands) and sensitive freshwater habitats (such as lakes, rivers, sloughs, ponds, prairie potholes, creeks, marshes, streams, reservoirs and wetlands).

Method of application	Crop		Spray buffer zones (metres) required for the protection of:		
			Freshwater habitat of depths:		Terrestrial habitat:
			Less than 1 m	Greater than 1 m	
Field sprayer	Field crops at 0.38–0.5 L/ha		1	0	3
	Field crops at 0.75 L/ha		1	0	5
Aerial	Field crops at 0.38 L/ha	Fixed wing	1	0	85
		Rotary wing	1	0	70
	Field crops at 0.5 L/ha	Fixed wing	1	0	100
		Rotary wing	1	0	85
	Field crops at 0.75 L/ha	Fixed wing	1	0	150
		Rotary wing	1	0	125

When tank mixes are permitted, consult the labels of the tank-mix partners and observe the largest (most restrictive) spray buffer zone of the products involved in the tank mixture and apply using the coarsest spray (ASAE) category indicated on the labels for those tank mix partners.

The spray buffer zones for this product can be modified based on weather conditions and spray equipment configuration by accessing the Spray Buffer Zone Calculator on the Pesticides portion of the Canada.ca website.

7) For CAZIVA ULTRA Q, PCP no. 34282, add to **DIRECTIONS FOR USE**:

Field sprayer application: DO NOT apply during periods of dead calm. Avoid application of this product when winds are gusty. DO NOT apply with spray droplets smaller than the American Society of Agricultural Engineers (ASAE S572.1) medium classification. Boom height must be 60 cm or less above the crop or ground.

DO NOT apply by air.

Product specific precautions
Read and understand the entire label before opening this product. If you have questions, call the manufacturer at (XXX) YYY-ZZZZ or obtain technical advice from the distributor or your provincial agricultural representative. Application of this specific product must meet and/or conform to the following:

Volume: Apply the recommended rate in a minimum spray volume of 55 litres per hectare.

SPRAY BUFFER ZONES
A spray buffer zone is NOT required for:

- low-clearance hooded or shielded sprayers that prevent spray contact with crop, fruit or foliage,

The spray buffer zones specified in the table below are required between the point of direct application and the closest downwind edge of sensitive terrestrial habitats (such as grasslands, forested areas, shelter belts, woodlots, hedgerows, riparian areas and shrublands) and sensitive freshwater habitats (such as lakes, rivers, sloughs, ponds, prairie potholes, creeks, marshes, streams, reservoirs and wetlands).

Method of application	Crop	Spray buffer zones (metres) required for the protection of:		
		Freshwater habitat of depths:		Terrestrial habitat:
		Less than 1 m	Greater than 1 m	
Field sprayer	Field crops at 0.38–0.5 L/ha	1	0	3
	Field crops at 0.75 L/ha	1	0	5

When tank mixes are permitted, consult the labels of the tank-mix partners and observe the largest (most restrictive) spray buffer zone of the products involved in the tank mixture and apply using the coarsest spray (ASAE) category indicated on the labels for those tank mix partners.

The spray buffer zones for this product can be modified based on weather conditions and spray equipment configuration by accessing the Spray Buffer Zone Calculator on the Pesticides portion of the Canada.ca website.

3.0 Additional label amendments

For all end-use products registered for use on sugarbeets, under the sub-section of "**Sugarbeets"** or **"FOR SALE FOR USE ON SUGARBEETS IN CANADA**" in the **DIRECTIONS FOR USE** section corresponding to the use on sugarbeets, add:

The minimal re-treatment interval (RTI) is 14 days.

Not all labels have the required preharvest intervals (PHIs), therefore, all end-use product labels must be updated to include the following PHIs:

- The PHI is 64 days for Oriental mustard (including canola quality *brassica juncea*) (condiment and oilseed type) (Western Canada only), yellow and brown mustard, and crambe.
- The PHI is 85 days for chickpeas.
- When tank mix partners are used, the most restricted PHIs must be observed.

References

A. Information considered in the updated chemistry assessment

Studies/Information submitted by the registrant

PMRA Document Number	Title
1442074	2006, Quizalofop-P-Ethyl Technical (DPX-79376) Analysis of Product Ingredients for Quizalofop-P-Ethyl Technical Produced at DACO: 2.13, 2.13.1, 2.13.2, 2.13.3, 2.13.4
1479092	1995, Product Chemistry of Quizalofop-P-Ethyl (D(+) NC-302) Technical. I of II. DACO: 2.1, 2.10, 2.14.1, 2.14.10, 2.14.12, 2.14.13, 2.14.14, 2.14.2, 2.14.3, 2.14.4, 2.14.5, 2.14.6, 2.14.7, 2.14.8, 2.14.9, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9
1479161	1996, Submission of a Manufacturing Process Change for Quizalofop-P-Ethyl (D(+) NC-302) Technical, DACO: 2.11.1, 2.11.3, 2.12
2411581	2013, Technical grade quizalofop-p-ethyl (DPX-79396) manufacturing description and formation of impurities, DACO: 2.11.1, 2.11.2, 2.11.3, 2.11.4, 2.12.1
2413238	2013, Product Chemistry Of Quizalofop-P ethyl Technical Product, DACO: 2.11.1, 2.11.2, 2.11.3, 2.11.4, 2.12.1
2413239	2013, Determination of Active Content and Impurity Profile of Quizalofop-P-ethyl, DACO: 2.13.1, 2.13.2, 2.13.3, 2.13.4
2422715	2013, Batch Analysis of Quizalofop-p-ethyl (DPX-79376) technical, DACO: 2.13.3
2423132	2014, Technical grade quizalofop-p-ethyl (DPX-79376) manufacturing description and formation of impurities, DACO: 2.11.1, 2.11.2, 2.11.3, 2.11.4
2423146	2013, Batch Analysis of Quizalofop-p-ethyl (DPX-79376) Technical, DACO 2.13.3
2540373	2015, Quality control data, DACO: 2.12
2540365	2015, Quality control data, DACO: 2.12
2546173	2015, Batch analysis of Quizalofop-p-ethyl (DPX-79376) Technical, DACO: 2.13.3
2546148	2015, Batch analysis of Quizalofop-p-ethyl (DPX 79376) Technical, DACO: 2.13.3
2761226	2008, Preliminary Analysis and Enforcement Analytical Method of Quizalofop-p-ethyl TGAI, DACO: 2.13, 2.13.1, 2.13.3
2761228	2017, Quizalofop-p-ethyl: Determination of the Chemical and Physical Properties, DACO: 2.14, 2.14.1, 2.14.11, 2.14.12, 2.14.15, 2.14.2, 2.14.3, 2.14.4, 2.14.6, 2.14.7, 2.14.8, 2.14.9, 830.7000
2775688	2013, Establishing Certified Limits, DACO: 2.11.4, 2.12.1, 2.13.1, 2.13.2, 2.13.3
2775689	2014, Odour, DACO: 2.14.1,2.14.2,2.14.3
2775692	2014, Melting Point/Melting Range, DACO: 2.14.4
2775693	2014, Boiling Point/Boiling Range, DACO: 2.14.5
2775691	2014, Density Or Specific Gravity, DACO: 2.14.6
2775695	2014, Water Solubility (MG/L), DACO: 2.14.7

PMRA Document Number	Title
2775696	2014, Solvent Solubility (MG/L), DACO: 2.14.8
2775698	2014, Vapour Pressure, DACO: 2.14.9
2775697	2014, Octanol/Water Partition Coefficient, DACO: 2.14.11
2775700	2014, UV/Visible Absorption Spectra, DACO: 2.14.12
2775701	2014, Storage Stability Data, DACO: 2.14.14
2775690	2014, Quizalofop-P-ethyl TC (Technical): Determination of the pH value, DACO: 2.14.15,830.7000
2822749	2017, Impurities of Toxicological Concern, DACO: 2.13.1,2.13.4
2832419	2017, Determination of in quizalofop-p-ethyl Technical, DACO: 2.13.4
2844540	2017, Confirmation of Identity, DACO: 2.13.1, 2.13.2, 2.13.3, 2.13.4
2844541	2017, Storage Stability and Corrosion Characteristics, DACO: 2.14.1, 2.14.13, 2.14.15, 2.14.2, 2.14.3, 830.7000
2844545	2008, Quizalofop-P-ethyl Determination of melting point/melting range, boiling point/ boiling range, DACO: 2.14.4, 2.14.5
2844546	2008, Density Or Specific Gravity, DACO: 2.14.6
2844547	2016, Quizalofop-p-ethyl (pure): Determination of the Water Solubility, DACO: 2.14.7
2844548	2016, Solvent Solubility (MG/L), DACO: 2.14.8
2844549	2016, Vapour Pressure, DACO: 2.14.9
2844542	2008, Dissociation Constant, DACO: 2.14.10
2844543	2016, Octanol/Water Partition Coefficient, DACO: 2.14.11
2844544	2008, UV/Visible Absorption Spectra, DACO: 2.14.12
2844551	2018, Chemical Abstracts Registry Number, DACO: 2.11.1, 2.11.2, 2.11.3, 2.11.4, 2.12.1, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9
2822748	2017, Manufacturing Methods For the TGAI, DACO: 2.11
2822749	2017, Impurities Of Toxicological Concern, DACO: 2.13.1, 2.13.4
2904385	2015, Manufacturing Process Synthesis Pathway: Quizalofop-P-ethyl Technical, DACO: 2.11, 2.11.1, 2.11.2, 2.11.3, 2.13.4
2950908	2013, 5Batch analysis of Quizalofop-p-Ethyl TC to meet international Regulatory Requirements, DACO: 2.13.1,2.13.2,2.13.3,2.13.4
2950909	2014, Quizalofop-P-Ethyl TC (Technical): Determination of the Colour, Odour and Physical State, DACO: 2.14.1,2.14.2,2.14.3
2950910	2014, Quizalofop-P-ethyl (Technical): Determination of Melting Point, DACO: 2.14.4
2950911	2014, Quizalofop-p-ethyl TC (Technical): Determination of Relative Density, DACO: 2.14.6
2950912	2014, Quizalofop-p-ethyl TC (Technical): Determination of the water solubility, DACO: 2.14.7
2950913	2014, Quizalofop-P-Ethyl TC (Technical): Determination of the solubility in Organic Solvents, DACO: 2.14.8
2950914	2014, Quizalofop-P-Ethyl TC (Technical): Determination of the Vapour Pressure, DACO: 2.14.9

PMRA Document Number	Title
2950916	2014, Quizalofop-P-ethyl TC (technical): Deternination of the Partition coefficient (n-octanol/water), DACO: 2.14.11
2950917	2014, Quizalofop-P-Ethyl TC (Technical): UV/Vis Spectra, DACO: 2.14.12
2950918	2014, Quizalofop-P-Ethyl TC (Technical): Determination of the Accelerate Storage Stability and corrosion Characteristics, DACO: 2.14.13
2950919	2014, Quizalofop-P-Ethyl TC (Technical): Determination of the pH Value, DACO: 2.14.15, 830.7000
2967317	2019, Five batch analysis of quizalofop-P-ethyl technical product, DACO: 2.12.1, 2.13.2, 2.13.3
2976236	2019, Manufacturing Process of Quizalofop-p-ethyl TC Revised, DACO: 2.11
2976238	2017, Five batch analysis of Quizalofop-p-ethyl TC: Quantification of Hyrdoquinone content, DACO: 2.13.4
3098983	2020, Manufacturing Process of Quizalofop-P-Ethyl in Manufacturing Plant, DACO: 2.11.1, 2.11.2, 2.11.3, 2.11.4, 2.12.1, 2.13.1, 2.13.2, 2.13.3
3098984	2019, Five Batch Analysis of quizalofop-P-ethyl Technical Product, DACO: 2.12.1,2.13.2,2.13.3
3101530	2020, REVISED - Manufacturing Process of Quizalofop-P-Ethyl in Plant, DACO: 2.11.3
3263427	2018, Five Batch Analysis of Quizalofop-P-ethyl Technical Product, DACO: 2.13.3,2.13.4
3263428	2016, Five Batch Analysis of Quizalofop-P-ethyl Technical Product, DACO: 2.13.4
3267879	2021, Manufacturing Process For Quizalofop-P-Ethyl Technical, DACO: 2.11

B. Information considered for the updated toxicological assessment

Studies/Information submitted by the registrant

PMRA Document Number	Title
1161247	1987. Ames Salmonella Mammalian Microsomal Reverse Mutation Test of D-NC 302. L 08156, DACO 4.5.4
1161250 1161251	1991. DNA Repair assay in primary rat hepatocyte cultures on D-NC 302, DACO 4.5.8
1161268	1987. Acute oral toxicity study of NC-302 (Dextro plus R compound) in rats, DACO: 4.2.1
1161273	1987. Acute oral toxicity study of NC-302 (Dextro plus R compound) in rats, DACO: 4.2.1

PMRA Document Number	Title
1161274	1995. Primary dermal irritation study with in Y6202 D+ isomer in rabbits, DACO: 4.2.5
1161275	1995. Closed-patch repeated insult dermal sensitization study (Buehler method) with in Y6202 D+ isomer in guinea pigs. DACO: 4.2.6
1161277, 1161276	1995. 90-day oral (dietary) toxicity study of D-NC 302 in mice, DACO: 4.3.4
1161278	1995. 90-day oral (dietary) toxicity study of D-NC 302 in rats, DACO: 4.3.4
1165846	1996. Mouse and rat organ to body weight ratio tables, DACO: 4.4.1
1165848	1996. Eighteen-month oncogenicity studies in CD-1 mice. Glossary of Nomenclature, DACO: 4.4.2
1165849	1996. Combined chronic toxicity/oncogenicity study with male and female rats, DACO: 4.4.4
1184251, 1184272, 1222753, 1222755, 1222757, 1223781, 1224007, 1224020, 1224034, 1224036, 1224038 1223697	1984. NC-302: Tumorigenicity/toxicity to rats by dietary administration, DACO: 4.4.2
1222753 1222759, 1222761, 1222762, 1222764, 1222766, 1222768, 1222770, 1222772, 1222775, 1224046, 1224107, 1224151, 1224159, 1224729 1184254	1985. Oncogenicity study in mice NC302 final report (all volumes), DACO: 4.4.3

PMRA Document Number	Title
1224031 1184271 1224163	1986. NC-302: 52 week oral (dietary administration) toxicity study in the beagle dog, DACO: 4.3.2
1224042	1983. Metabolism of NC-302 in rats, DACO: 4.5.9 (reported as 6.4)
1224110 1224148	1985. Two-generation reproduction study in rats with INY-6202, DACO: 4.5.1
1224167 1224169 1224728 1184263	1981. Acute oral toxicity of NC-302 in mice, DACO: 4.2.1
1224168 1184262	1981. Acute oral toxicity of NC-302 in rats, DACO: 4.2.1
1224171 1184264	1981. Acute dermal toxicity of NC-302 in rats, DACO: 4.2.2
1224172 1184266	1983. Inhalation median lethal concentration (LC50) of INY-6202-15 by EPA protocol, DACO: 4.2.3
1224173	1984. Irritant effects of NC-302 technical product on rabbit eye mucosa, DACO: 4.2.4
1224174 1224175	1984. Irritant effects of NC-302 technical product on rabbit skin, DACO: 4.2.5
1224180	1984. Screening test for delayed contact hypersensitivity with nc-302 technical product in the albino guinea pig, DACO: 4.2.6
1224183 1184249	1984. Subchronic dietary toxicity study in mice, DACO: 4.3.1
1224184 1184250 1224232	1984. NC-302 Potential toxicity to rats when administered in the diet for 13 weeks followed by a 6-week recovery period, DACO: 4.3.1
1224185 2719113	1985. Metabolism of [quinoxaline-^{14}C] and [phenyl-^{14}C(U)] DPX-Y6202 in rats, DACO: 6.4
1224233 1184259	1983. Chromosome test with NC302 on Chinese hamster cell in vitro, DACO: 4.5.4
1224234 1184258	1984. CHO/HGPRT assay for gene mutation, DACO: 4.5.4
1224243 1184251	1984. Subchronic toxicity study in dogs with NC-302 by oral administration for 26 weeks, DACO: 4.3.1
1224252	1983. The accumulation of NC-302 and its metabolites in the tissues of rats during repeated oral administration, DACO: 6.4
1224253	1983. The biokinetics and metabolism of ^{14}C-NC 302 in the rat, DACO: 6.4
1224265 1184255	1983. Effect of NC-302 on reproduction (Experimental administration of NC-302 to pregnant rats during the period of organ formation in embryos). DACO: 4.5.2

PMRA Document Number	Title
1224266 1224737	1983. Effect of NC-302 on pregnancy of the New Zealand White rabbit (experimental administration of NC-302 to pregnant rabbits during the period of organ formation of embryos), DACO: 4.5.2
1224268 1184256	1984. Mutagenicity testing on NC302 in microbial systems. DACO: 4.5.4
1224269 1184261	1981. Micronucleus test with NC302 in mice, DACO: 4.5.4
1224270 1184260	1984. Unscheduled DNA synthesis/rat hepatocytes in vitro, DACO: 4.5.4
1224722	1984. Liver enzyme induction study of NC-302 in female mice, DACO: 4.3.8
1224724	1984. Liver enzyme induction study of NC-302 in male mice, DACO: 4.3.8
1224725	1984. Liver enzyme induction study of NC-302 in male and female rats, DACO: 4.3.8
1224726	1985. The effect of FBC 32197 (ethyl 2-[4-(6-chloro-2-quinoxzyloxy)-phenoxy] propionate) on the mixed function oxidase system of the male mouse, DACO: 6.4
2717605	2011. Quizalofop-P-Ethyl Technical: 28-Day Immunotoxicity Feeding Study in Mice, DACO: 4.8
2719113	1986. Metabolism of [quinoxaline-^{14}C] and [phenyl-^{14}C(U)] DPX-Y6202 in rats, DACO: 4.5.9
2719116 1224069 1224181 1224077	1983. Twenty-one day dermal toxicity of INY-6202-15 in male and female rabbits, DACO: 4.3.4
2719119	2011. Quizalofop-P-ethyl technical: 28 day immunotoxicity feeding study in mice, DACO: 4.8
2719123	2010. Quizalofop-P-ethyl Immunotoxicity study: Justification for test species and dose selection, DACO: 4.8

Additional information considered

Published information

PMRA Document Number	Title
	Conclusion regarding the peer review of the pesticide risk assessment of the active substance quizalofop-P (considered variants quizalofop-P-ethyl and quizalofop-P-tefuryl). *EFSA Scientific Report* (2008) 205, 1-216. https://www.efsa.europa.eu/en/efsajournal/pub/rn-205

	Evidence on developmental and reproductive toxicity of quizalofop-ethyl: Reproductive and Cancer Hazard Assessment Section (RCHAS) Office of Environmental Health Hazard Assessment (OEHHA) California Environmental Protection Agency (CAL/EPA) DRAFT September, 1999 James Donald, Ph.D. https://oehha.ca.gov/media/downloads/proposition-65/chemicals/hidquiz.pdf
	EPA: Quizalofop-P-ethyl**.** Human Health Risk Assessment in Support of the Proposed. New Use on Quizalofop-Tolerant Wheat. PC Code: 128709. December 13, 2017 https://www.regulations.gov/document?D=EPA-HQ-OPP-2016-0360-0016
3130950	Clancy B, Darlington RB, Finlay BL. Translating developmental time across mammalian species. Neuroscience. 2001;105(1):7-17. PMID: 11483296. DOI: 10.1016/s0306-4522(01)00171-3
3130959	Liang Y, Wang P, Liu D, Shen Z, Liu H, Jia Z, et al. (2014) Enantioselective Metabolism of Quizalofop-Ethyl in Rat. PLoS ONE 9(6): e101052. https://doi.org/10.1371/journal.pone.0101052 doi: 10.1371/journal.pone.0101052 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4071037/
3187225	Shaner, Dale L. (2004). Herbicide safety relative to common targets in plants and mammals. Pest Management Science. 60(1):17-24. https://doi.org/10.1002/ps.782|
	I.C. Burke, J.L. Bell, Encyclopedia of Agriculture and Food Systems, 2014. Plant Health Management: Herbicides. Acetyl-CoA Carboxylase Inhibitors (Group A) Pages 425-440. https://doi.org/10.1016/B978-0-444-52512-3.00181-9

C. Information considered in the updated dietary assessment

Studies/Information submitted by the registrant

PMRA Document Number	Title
1166178	1992. Metabolism of [Quinoxaline-Phenyl(U)-14C]-DPX-Y6202, [Phenyl(U)-14C]DPX-Y6202,[Quinoxaline-Phenyl(U)-14C]DPX-79376 and [Phenyl(U)-14C]DPX-79376 in Soybean, DACO: 6.3
1166179	1991. Metabolism of [Phenyl(U)-14C]DPX-79376 and [Quinoxaline-Phenyl(U)-14C]DPX-79376 in Tomatoes, DACO: 6.3
1223757	1986. Metabolism of 14C-Labelled DPX-Y6202 by Lactating Goats, DACO: 6.4
1223759	1987. The Metabolism of [Quinoxaline-Phenyl(U)-14C] DPX-Y6202 in Laying Hens, DACO: 6.4,7.5
1224039	1983. Metabolism of NC-302 Ethyl 2-[4-(6-Chloro-2-Quinoxalyloxy)Phenoxy] Propionate in Plants, DACO: 6.3
1224040	1985. Metabolism of 14C-DPX-Y6202 in Field-Grown Cotton, DACO: 6.3
1224079	1984. Metabolism of the Aqueous-Soluble Soybean Metabolites of 14C-DPX-Y6202 in Dairy Cow Rumen Fluid, DACO: 6.4

PMRA Document Number	Title
1224182	1985. Metabolism of 14C-DPX-Y6202 in Field-Grown Soybean Plants, DACO: 6.3
1234116	1985. Extraction Characterization of 14C-Residues in Mature Seeds Collected from Soybean Plants Foliage-Treated with 14C-NC-302 at the Early Reproductive Stage, DACO: 6.3
1234118	1985. Absorption, Translocation and Metabolism of NC-302 in Potato Plants. Final Report, DACO: 6.3
1234172	1985. 14C-DPX-Y6202 Residue Study in Soybeans DACO: 7.4.2
1161252	1993. Validation Of Quizalofop P-Ethyl (DPX-79376), Quizalofop Acid (YE-945), Phenol 2 (IN-A6208), Phenol 3 (IN-G7057), and Phenol 4 (IN-H8515) in Cottonseed, Beans, Peas, Canola, and Sugarbeets, DACO: 7.2.1
1166180	1991, The Metabolism of [Quinoxaline-Phenyl(U)-14C]DPX-79376 and [Phenyl(U)-14C]DPX-79376 in Sugar Beet, DACO: 6.3
1171106	1997, Analytical Phase Report: Residues of Quizalofop-P-Ethyl and Metabolites in Canola, Flax, Lentil and Peas Grown in Canada, DACO: 7.2.1
1223752	1984. Determination of Residues of DPX-Y6202 in Crops DACO: 7.2.1
1223753	Determination of Residues of DPX-Y6202 Acid Metabolite in Crops, DACO: 7.2.1
1224044	1983. Determination of Residues of DPX-Y6202 and DPX-Y6202 Acid in Soybeans, DACO: 7.2.1
1224100	1986. Determination of Residues in Soybeans, DACO: 7.2.1
1224101	1986. Determination of Herbicide Candidate in Soybeans and Soybean Fractions, DACO: 7.2.1
1224103	1987. Determination of Residues in Soybeans and Soybean Fractions, DACO: 7.2.1
1224187	1986. Determination of Residues in Soybeans, DACO: 7.2.1
1234150	1990. Magnitude of DPX-Y6202 Residues in Canola Seeds & Processed Fractions, DACO: 7.4.2,7.8
1234183	1987. Determination of Residue of DPX-Y6202, DPX-Y6202 Acid, and DPX-Y6202 Acid Conjugates in Soybeans & Soybean Fractions, DACO: 7.2.1
1234194	1982. Determination of Residue of DPX-Y6202, Metabolites Phenol I and Phenol 2 in Soybeans, DACO: 7.2.1
1166181	1993, Magnitude of Residues of Assure II Herbicide in Sugarbeets and Their Processed Fractions, DACO: 7.4.6
1168073	1996. Freezer Storage Study of Quizalofop P-Ethyl (DPX-79376), Quizalofop Acid (YE-945), Phenol 2 (IN-A6208), Phenol 3 (IN-G7057), and Phenol 4 (IN-H8515) in Cottonseed, Beans, Peas, Sugarbeets, and Canola, DACO: 7.3
1222559	1987. Determination of Residues in Tissues, DACO: 7.2.1,7.5
1222560	1987. Determination of Residues in Eggs, DACO: 7.2.1,7.5
1222561	1987. Determination of Residues in Bovine and Poultry Fat, DACO: 7.2.1,7.4.2

PMRA Document Number	Title
1222562	1986. Determination of Residues in Milk, DACO: 7.2.1,7.4.2
1222563	1987. Determination of Residues in Cream, DACO: 7.2.1,7.4.2
1223762	1986. Accumulation Study of on Rotational Crops, DACO: 7.4.2
1223764	1987. Determination of Residues of DPX-Y6202 and Metabolites in Tissues and Eggs of Chickens, DACO: 7.2.1,7.5
1224008	1984. Crop Rotation Study with 14C-DPX-Y6202 in the Greenhouse, DACO: 7.4.2
1224104	1987. Magnitude of Residue in Soybeans and Processed Soybean Fractions After Treatment, DACO: 7.4.2
1251312	1993. Magnitude of Residues of Assure II Herbicide in Canola Seed and its Processed Fractions, DACO: 7.4.1
2113605	1999. Independent Laboratory Validation of the Method for the Determination of Quizalofop-P-Ethyl and Quizalofop-P in Sunflower Seeds, DACO: 7.2.3
2113606	2008. Analytical Method for the Determination of Residues of Quizalofop-P-Ethyl and Quizalofop-P in Sunflower Seed, Mean And Oil, DACO: 7.2.1,7.2.2,7.2.4,7.2.5
2486604	1998. Determination of Quizalofop-P-Ethyl and its Metabolites in Canola, Flax, Lentils, Peas, Dry and Succulent Beans and Sugar Beet Tops and Roots, by Liquid Chromatography, DACO: 7.2.1
1009020	2004. Magnitude of Residues of Quizalofop-P-Ethyl in Chick Peas Following Application of Assure II Herbicide -Canada, 2002, DACO: 7.4.1
1076097	1999. Magnitude of Residues of Quizalofop-P-Ethyl in Succulent Beans Following Application of Assure II Herbicide at Maximum Label Rates, DACO: 7.8
1076098	1999. Magnitude of Residues of Quizalofop-P-Ethyl in Dry Beans Following Application of Assure II Herbicide at Maximum Label Rates, DACO: 7.8
1076469	1993. Magnitude of Residues of D+ Isomer of Assure Herbicide when Applied to Snap and Dry Beans, DACO: 7.4.6
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1311661	2001, Minor Use Project: Quizalofop-P-Ethyl on Rutabagas, DACO: 7.4.1
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3254883	2019. Quizalofop-P-ethyl Technical Honey Bee Larval (Apis mellifera L.) Toxicity Test following Repeated Exposure under laboratory conditions, DACO: 9.2.4.3
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3258162	2007. QUIZALOFOP-P-ETHYL TECHNICAL: Acute Oral and Contact Toxicity to Honey Bees (Apis mellifera L.), DACO: 9.2.4.1,9.2.4.2
1223769	1987. Field Dissipation of DPX-Y6202, (ASSURE), DACO: 8.3.2.3
1224010	1983. Environmental Chemistry Of Nc-302, Hydrolysis, Photolysis, Degradation In Soils, Soil Adsorption, Soil Desorption And Mobility, DACO: 8.2.1
1224012	1983. Aerobic Soil Metabolism of [14C]-Phenyl-Labeled DPX-Y6202, DACO: 8.2.3.1
1224013	1984. Aerobic Soil Metabolism of [14C-Quinoxaline-Labeled]-DPX-Y6202, DACO: 8.2.3.1
1224014	1985. Aerobic Soil Metabolism of [Phenyl-14C(U)] DPX-Y6202, DACO: 8.2.3.1
1224015	1985. Anaerobic Aquatic Metabolism of [Quinoxaline-14C] DPX-Y6202 and [Phenyl-14C(U)] DPX-Y6202, DACO: 8.2.3.1
1224047	1985. Field Soil Dissipation [Phenyl-14C(U)] and [Quinoxaline-14C] DPX-Y6202 in Delaware, North Carolina Illinois and Mississippi, DACO: 8.3.2.3
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1224189	1984. Photodegradation of [Quinoxaline-14C] DPX-Y6202 on Soil, DACO: 8.2.1
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1224238	1983. Hydrolysis of [14C]-Quinoxaline-Labeled DPX-Y6202, DACO: 8.2.1
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1164019	1991. 1-octanol/water partition coefficient of D(+) NCI-966831991, DACO: 8.2.1
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