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SUBJECT: RECOMMENDED REVISIONS TO THE PESTICIDE ACTION LEVELS FOR TESTING CANNABIS PRODUCTS IN CALIFORNIA

OBJECTIVE

The Department of Pesticide Regulation (DPR) submits this memorandum as part of its continuing efforts to meet the requirements in Business and Professions Code (BPC) section 26060 et seq. which, among other things, requires DPR to develop guidelines for action levels for pesticide residue in harvested cannabis. To comply with this requirement, DPR provides health-based recommendations for consideration by the Department of Cannabis Control (DCC) in establishing regulatory residue levels for pesticides on processed cannabis. As new data become available or when other information warrants review, DPR updates its recommendations.

In 2017, DPR provided DCC (then known as the Bureau of Cannabis Control (BCC)) with an initial proposed list of recommended action levels for 66 pesticides. These pesticides were decided on by consensus between BCC and DPR based on input from cannabis cultivators and informed by new consumer cannabis testing programs under development or established by the states of Colorado, Oregon, Washington and Nevada (Ajax, 2017). DPR recommended dividing the listed pesticides into two broad categories with Category I pesticides each having a maximum allowable residue limit set at detection and Category II pesticides each with a maximum allowable residue limit set above detection. Category I pesticides originally included those DPR identified as having potential human health or environmental risks including high acute toxicity, those included on DPR's Groundwater Protection List, neonicotinoid insecticides, restricted

material pesticides, pesticides that are not registered in California and those with no food uses (Ajax, 2017). DPR recommended action levels specific to cannabis goods and products designated as inhalable (e.g., cannabis flower and vape liquids) or as other cannabis goods (e.g., edible, topical) as defined in the California Code of Regulations, Title 4, Section 15700.

In September 2019, DPR reassessed the toxicity and hazard identification for 35 of the original 66 pesticides using relevant scientific data at the time. Based on that assessment, DPR recommended moving three Category I pesticides to Category II (based on acceptable food uses) and revising the action levels for another fifteen Category II pesticides. In January 2021, DPR recommended additional changes to another 16 Category II pesticides.

This memorandum supersedes the recommendations from 2017, 2019 and 2021 and provides updates based on new toxicology, current regulatory guidance levels, and evaluation of analytical data.

Summary of Recommendations

DPR recommends the addition of 14 pesticides for testing, and the revision of action levels for 31 pesticides currently recommended for testing. Recommendations for updated action levels are based on the review and assessment of new in vivo and in vitro toxicity data and pesticide residue analytical data as well as changes in risk assessment methodologies from regulatory agencies including the US Environmental Protection Agency (US EPA). In addition, DPR is recommending the establishment of risk-based action levels for all pesticides that are tested for in commercially available cannabis products in the California marketplace. This would result in a transition away from a two-category system of pesticide testing, with the goal of establishing health-based action levels for all listed pesticides. Updated recommendations will be provided on a rolling basis as new information becomes available and as DPR works to develop health-based action levels for newly identified pesticides of concern.

Pesticides Recommended for Addition to Analytical Testing

DPR recommends for adding the following pesticides to the list for testing: buprofezin, carbendazim, cyprodinil, dacthal (DCPA), fluopyram, methamidophos, monocrotophos, omethoate, pymetrozine, pyraclostrobin and pyrimethanil. The justification for these additions includes DCC reports of detections in cannabis products found in the California marketplace, high frequency of detection on food commodities by the US Department of Agriculture's (USDA) Pesticide Data Program[1] following legal pesticide

[1]US Department of Agriculture (USDA) Agricultural Marketing Service, Pesticides Data Program. A national pesticide residue monitoring program which includes sampling, testing, and reporting of pesticide

use, high frequency of detections on fresh fruit and vegetables in the California Pesticide Residue Monitoring Program (CPRMP)[2] samples following illegal pesticide use, and toxicologically relevant degradates and/or metabolites of the parent pesticide.

In addition, through various enforcement efforts, DPR has become aware of the use of the following pesticides associated with cannabis cultivation that are not registered for use in the United States: fenobucarb (BPMC), isoprocarb (MIPC), andprocymidone. DPR recommends that DCC take regulatory action to prohibit the sale or distribution of cannabis products with any detectable residue of these pesticides. DPR anticipates updating its recommendations to include health-based action levels for these and, as appropriate, other pesticides associated with cannabis cultivation that are identified through enforcement efforts. DPR is further aware of various media reports relative to pesticide residue on cannabis and California's laboratory testing program. DPR is reviewing this reporting and will update its recommendations as appropriate.

To the extent DCC determines it is appropriate to limit the number of pesticides subject to screening, it could consider deprioritizing two pesticides on the existing list, etofenprox and prallethrin. These pesticides could be a lower priority for testing based on a lack of detections in available post-market consumer cannabis products sampling data and relatively low human health risk. These pesticides are used in vector control products to protect public health and may be applied in proximity to cannabis cultivation. DPR has developed or updated health-based action levels for these pesticides that can be used.

BACKGROUND

Under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). US EPA reviews and approves pesticide product labels prior to their sale and use in the US that are specific to each crop and type of application. In addition, US EPA establishes maximum residual levels of pesticide that is permitted in or on food in the United States.

Cannabis remains federally illegal, and as a result US EPA has not established any tolerances for pesticides used on cannabis. In California, BPC section 26060(c) established a legal requirement for DPR to develop guidelines for residue in harvested cannabis. In compliance with this requirement, DPR developed health-based

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residues on agricultural commodities in the US food supply, with an emphasis on those commodities highly consumed by infants and children. https://www.ams.usda.gov/datasets/pdp

[2]California Pesticide Residue Monitoring Program. DPR samples individual lots of domestic and imported produce and analyzes them for pesticide residues to enforce the tolerances set by US EPA. Samples are collected from throughout the channels of trade, including wholesale and retail outlets, distribution centers, and farmers markets and tested with multiresidue screens capable of detecting more than 400 pesticides and breakdown products. https://www.cdpr.ca.gov/docs/enforce/residue/rsmonmnu.htm

recommendations for consideration by DCC in establishing regulator residue levels for pesticides on processed cannabis.

Exposure to Pesticides in Cannabis Products

One may be exposed to pesticide residues through inhalation, ingestion, and dermal exposure. The type of cannabis product used largely determines the potential route of exposure to any residual pesticide contamination. Inhalation of pesticide residues can occur when smoking dried cannabis flowers or inhaling vapors from processed cannabis products that are heated, melted or burned. Ingestion of pesticide residues can occur from using edible cannabis products and dermal exposure can occur from products applied topically. The human body has numerous processes that can affect the chemical's ability to cause adverse effects. Organs like the liver, kidneys and the lung contain enzymes that can breakdown chemicals and eliminate them before they can enter the bloodstream or activate them to produce more toxic compounds than the parent. Human skin is a significant barrier that can prevent many external chemicals from entering the body. The molecular structure of the pesticide is the most important determinant of how much can pass through the skin into the bloodstream (a term called the dermal absorption factor) or how long it may be bound on the skin. Compared to ingestion and dermal exposure, the inhalation route of exposure carries unique risks because heating or burning pesticides during smoking or vaping cannabis products may release toxic pyrolysis or thermal decomposition products such as hydrogen cyanide or chlorine compounds (Chen et al., 2011), which can directly enter the bloodstream from the lungs.

Methodology for Deriving Pesticide Action Levels for Cannabis Products

To be consistent with other states regulating cannabis, in 2017 DPR recommended the use of the term action levels to establish minimum testing criteria for pesticide residues remaining in cannabis products designated for the marketplace in California. DPR developed two distinct approaches to deriving pesticide residue levels in manufactured cannabis products depending on the anticipated use: inhalable or other cannabis products (e.g., edible and topical).

As described above, the exposure route is an important consideration for the toxicity of pesticides and other chemicals. Because of the risks inherent with inhalation exposure, specific action levels were established for cannabis products that are used or consumed through that route, such as dried flower, concentrate and vape pens/cartridges. A separate set of action levels was established for edible cannabis products and those that can be applied topically. This combined set of action levels defined in the California Code of Regulations (CCR) Title 4 section 15700 as "Other Cannabis Goods" covers such products as cookies, gummies, beverages, tinctures, lotions, and oils.

California was the first state to develop action levels on allowable pesticide residues in cannabis products based on public health consideration. There is currently limited available information about pesticide residue and consumption specific to cannabis. To that end, DPR commissioned an academic survey of legal cannabis consumption in the California marketplace called the California Cannabis Consumption (C3) Survey, DPR anticipates releasing final analysis in 2025. For purposes of this memorandum, DPR refers to the methodologies established in 2017 and further refined from 2018–2021 for proposing changes to action levels.

Deriving Action Levels for Inhalable Cannabis Products

Based on currently available data, despite an increase in the popularity of edibles, the primary method of cannabis consumption continues to be inhalation via smoking (71%) or vaping (27%) (CDPHE 2022). There is currently limited data specifically characterizing pesticide inhalation exposure from smoking cannabis (Raber et al., 2015; Sullivan et al., 2013; Vreek et al., 2022). However, due to similarities in pesticide application methods and product consumption, DPR has determined that tobacco is a suitable surrogate for purposes of estimating risk and references two sources from other regulatory agencies in establishing action levels for inhalable cannabis products.

Firstly, DPR adopted the Guidance Residue Levels (GRL) for pesticides on tobacco established by Cooperation Centre for Scientific Research Relative to Tobacco (CORESTA), an international cooperative research center for tobacco headquartered in France (CORESTA, 2016). DPR used the CORESTA GRLs as the action levels for dried cannabis flowers as these levels reflect the highest acceptable residues resulting from agricultural practices, detection limits, and physical and chemical properties. If a GRL has not been established for a pesticide, then the US EPA regulatory level of 0.1 µg/g (0.1 parts per million, ppm) was used as a surrogate action level for inhalable cannabis products. This is the pesticide residue level for tobacco that triggers the US EPA to require pyrolysis testing (US EPA, 1996). The information gathered from the pyrolysis tests is then evaluated for possible significance to human health.

The recommended revisions to the pesticide action levels for inhalable cannabis products herein reflect updates from CORESTA or US EPA on their respective values for pesticides on tobacco. DPR anticipates that these values may be further refined when final data from the California Cannabis Consumption (C3) Survey will be incorporated into its methodology for establishing action levels in future updates.

Deriving Action Levels for Edible and Topical (“Other”) Cannabis Products

While smokeable/inhalable cannabis products make up the majority of products available in the legal marketplace, California consumers have access to a variety of other types of cannabis products. These products include edibles likes gummies, infused cookies, and infused drinks, topical solutions like lotions and balms, or tinctures

or drops that can be added to food or applied under the tongues. DPR developed a health-based methodology for establishing action levels for edible cannabis products described in further detail below. However, DPR did not calculate specific action levels for topical cannabis products because of the unavailability of data to do so. Instead, DPR used the calculation of edible product consumption as a surrogate for dermal absorption (DPR, 2017). Human skin is a significant barrier that can prevent many external chemicals from entering the body. Compared to dermal exposure, ingestion generally results in higher internal exposure to pesticide residues from cannabis products. Basing action levels for topical products on edible products is a conservative approach to protect human health, therefore the action levels listed under "Other Cannabis Goods" are health-based action levels developed using oral pesticide exposure. DPR intends to refine topical levels in the future using dermal absorption data and topical consumption data once they become available.

Methodology for Deriving Action Levels for Edible Cannabis Products

Consumption data are currently not available for ingestible cannabis products such as cannabis-infused edibles, beverages, tinctures, and capsules. Therefore, DPR developed a surrogate method using an agricultural commodity with known consumption data. The approach used is based on the same methodology that DPR's California Pesticide Residue Monitoring Program (CPRMP) uses to evaluate potential health risks from illegal pesticide residue detected on raw produce. It requires two variables: a reference dose (RfD) and a consumption rate, according to the equation below.

$$\text{Action Level } (\mu g \text{ pesticide/g cannabis}) = \frac{\text{Reference Dose (mg pesticide/kg body weight-day)} \times (1000\mu g/1mg)}{\text{Cannabis Consumption Rate* (g cannabis/kg body weight-day)}}$$

** Cannabis Consumption Rate is currently based on a surrogate consumption rate of other agricultural commodities until cannabis-specific data can be analyzed.*

As defined by the US EPA, an acute RfD is an estimate of a daily oral chemical (such as pesticide) exposure for an acute duration (24 hours of less) to the human population including sensitive subgroups that is likely to be without appreciable risk of deleterious effects during a lifetime (US EPA, 2024a). RfDs were compiled from multiple sources including from DPR's own risk assessments for specific active ingredients,[3] RfDs established specifically for CPRMP, values from US EPA's Human Health Benchmark

[3]Department of Pesticide Regulation, Human Health Risk Assessment and Mitigation by Active Ingredient, https://www.cdpr.ca.gov/docs/whs/active_ingredient/index.htm

database (US EPA 2024b), searches of the US EPA Pesticide Chemical Search website,[4] or the European Food Safety Authority (EFSA).[5] Generally, the most recent acute RfD was chosen, or otherwise the most health conservative value was selected. If no acute RfD was available, a sub-chronic or chronic RfD was used instead. When population-adjusted doses for sensitive populations (children and women of childbearing age) were available, these values were incorporated into the calculations.

DPR identified commodities with high consumption rates to account for the variety of cannabis-containing edible products as well as the large range in consumption rates of these products. For CPRMP, DPR uses watermelon to establish a reasonable daily maximum consumption rate for the types of commodities that are tested for pesticide residues in California. DPR uses the 100th percentile consumption rate as the screening level for dietary evaluations and the 95th percentile consumption level to evaluate potential risk. To be consistent with the CPRMP, DPR used the 95th percentile consumption rate for watermelon to calculate the risk-based action levels for edible cannabis products. The 95th percentile consumption rate for watermelon was 20 g/kg-body weight, based on the consumption records from the 2005–2010 National Health and Nutrition Examination Survey (NHANES) database (NCHS, 2016; US EPA, 2014). Next, DPR compared health-derived action levels to the lowest US EPA tolerances in other fruit or vegetable crops,[6] selecting the lower of two values so that the action levels are health protective and do not exceed existing tolerances for other commodities. Finally, the action level is calculated with the pesticide-specific RfD and the surrogate consumption data using the equation referenced at the beginning of this section.

Action levels for edible cannabis products are not equivalent to a US EPA tolerance. In establishing tolerances for pesticide residues in food, US EPA conducts a dietary risk assessment to account for the eating habits of different segments of the population and combines that information with other lifetime routes of exposure to ensure that the pesticide can be used with reasonable certainty of no harm. When establishing tolerances, US EPA also considers expected residue levels from labeled pesticides use, another dataset unavailable for cannabis at this time since no pesticides are designated as legal at the federal level for application on cannabis as a crop.

The action levels proposed herein for edible cannabis products (“Other Cannabis Goods”) should not exceed established US EPA tolerances for fruit and vegetable

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[4]US Environmental Protection Agency, Office of Pesticide Programs, Pesticide Chemical Search, https://ordspub.epa.gov/ords/pesticides/f?p=chemicalsearch:1

[5] European Food Safety Authority https://www.efsa.europa.eu/en; EU Pesticides Database, https://food.ec.europa.eu/plants/pesticides/eu-pesticides-database_en

[6]Title 40 Part 180 Code of Federal Regulations, Volume 26 Chapter I Subchapter E. Part 180 - Tolerances and Exemptions for Pesticide Chemical Residues In Food. Authority: 21 U.S.C. 321(q), 346a and 371. Source: 36 FR 22540, Nov. 25, 1971, unless otherwise noted. Available at https://ecfr.io/Title-40/pt40.26.180

crops. In cases where the calculated action level exceeded the highest US EPA tolerance established for a fruit or vegetable crop, the US EPA tolerance was substituted as the action level. This is a more health protective approach.

It should also be noted that California tests processed cannabis products. Edible cannabis products may contain other agricultural commodities such as wheat flour, rolled oats, corn syrup or cane sugar. Results from analytical pesticide residue analysis may show the total concentration of a pesticide in a manufactured cannabis product, not just the pesticide residue on the cannabis.

PESTICIDE RESIDUE TESTING IN LEGALLY GROWN CANNABIS

In 2017, DPR proposed a list of pesticides recommended for testing in processed cannabis products. This list was compiled from lists generated by other states with legal cannabis use including Oregon and Colorado at the time. DPR added additional pesticides based on conversations with cannabis cultivators and other industry experts, as well as certain pesticides with known health or environmental concerns. This resulted in a list of 66 pesticides, which was then subdivided into two categories. Category I included 21 pesticides not currently registered by DPR for food use in California or that have low reference doses (RfDs). DPR recommended that no detectable residue be allowed for these pesticides. Category II included the remaining 45 pesticide which are currently registered by DPR for food use in California and for which DPR established health-based action levels.

In the ensuing eight years, numerous changes have occurred in the legal cannabis industry in California, including in the establishment of the DCC and its associated regulatory framework. As such, DPR is recommending revisions to the list of pesticides tested and to numerous action levels for inhalable and other cannabis products. These recommendations are based on DCC reports of detections in cannabis products found in the California marketplace, real use scenarios, and revised/updated human health effects and toxicity data.

It is important to note that analytical detection of pesticides has undergone significant technical advancement, such that pesticide residues can be detected at or below the parts-per-billion range. Analytical detection of pesticide residues alone does not equate to a health risk. The risk to human health is dependent both on the toxicity of a pesticide and the amount someone is exposed to. Both toxicity and exposure have been accounted for in developing and refining the recommended action levels found in this memorandum. Further refinements will occur as additional exposure or toxicity data become available. There are four instances in this memorandum where the conservative health-protective recommendations result in action levels in the parts per

billion range (for carbofuran, chlorpyrifos, methyl parathion, and monocrotophos) and approach current analytical capabilities for detection.

Pesticides Recommended for Addition to Mandatory Testing

DPR used four data sources as the basis for recommending additional pesticides for mandatory residue testing. First, DCC reports of detections in cannabis products found in the California marketplace; second, a focused analysis of pesticides detected in high frequency on food commodities by the USDA Pesticide Data Program (PDP) following legal pesticide use; third, high frequency of illegal residue detections on fresh fruits and vegetables in California Pesticide Residue Monitoring Program (CPRMP) samples; and fourth, incorporation of data from revised US EPA risk assessments. The reasoning behind the use of PDP and CPRMP data to inform recommendations for additional pesticides is that the use of pest management products in conventional agriculture may influence cannabis cultivation practices in California, as cross-over of tools and remedies may occur between these two industries. DPR's data evaluation of pre- and post-market pesticide analyses provided by DCC confirmed DPR's concern with detections above the limit of detection (LOD) for several pesticides DPR recommends adding to mandatory testing. The summary of recommended additions to mandatory testing are found in Table 1, below. Media reports also suggest commercial laboratories have also found some of the pesticides recommended for addition (Los Angeles Times, 2024a, 2024b; Medical Express News, 2024).

Table 1. Summary of pesticides recommended for addition to mandatory residue testing of legally grown cannabis in California

Pesticide[a]	CAS No.	Reason for Addition
Buprofezin	69327-76-0	Reports of detections on cannabis products and high frequency of detection on food commodities by the USDA PDP following legal pesticide use, and
Carbendazim	10605-21-7	High frequency of illegal residue detections on fresh food and vegetables in the CPRMP samples
Cyprodinil	121552-61-2	Reports of detections on cannabis products and high frequency of detection on food commodities by the USDA PDP following legal pesticide use.
Dacthal (DCPA)	1861-32-1	New data concerning developmental neurotoxicity at very low exposure levels, cancellation of all DCPA products in the United States, and high frequency of detection on food commodities by the USDA PDP following legal pesticide use.
Fluopyram	658066-35-4	Reports of detections on cannabis products and high frequency of detection on food commodities by the USDA PDP following legal pesticide use

Table 1. Summary of pesticides recommended for addition to mandatory residue testing of legally grown cannabis in California

Pesticide[a]	CAS No.	Reason for Addition
Methamidophos	10265-92-6	Toxic metabolite/degradate of acephate
Monocrotophos	6923-22-4	High frequency of illegal residue detections on fresh food and vegetables in the CPRMP samples
Omethoate	1113-02-6	Toxic metabolite/degradate of dimethoate
Pymetrozine	123312-89-0	Reports of detections on cannabis
Pyraclostrobin	175013-18-0	High frequency of detection on food commodities by the USDA PDP following legal pesticide use
Pyrimethanil	53112-28-0	Reports of detections on cannabis products and high frequency of detection on food commodities by the USDA PDP following legal pesticide use

[a]Unless otherwise noted, pesticide-specific tolerances used by the USDA Pesticide Data Program (PDP) and the California Pesticide Residue Monitoring Program (CPRMP) are found in Title 40 Part 180 Code of Federal Regulations, Volume 26 Chapter I Subchapter E. Part 180 - Tolerances and Exemptions for Pesticide Chemical Residues In Food. Authority: 21 U.S.C. 321(q), 346a and 371. Source: 36 FR 22540, Nov. 25, 1971, unless otherwise noted. Available at https://ecfr.io/Title-40/pt40.26.180

Various state and local law enforcement agencies have been involved in taking action to support that cannabis operations' compliance with numerous applicable legal requirements. DPR is aware that through these and other enforcement efforts there is evidence of the use of illegal pesticides (those not registered for use in the United States) associated with cannabis cultivation (Table 2). DPR is aware of additional pesticides that are not registered for use in the United States detected in illegal cannabis grows (Table 2). This has been corroborated by recent media reports (Los Angeles Times, 2024a, 2024b; Medical Express News, 2024). On that basis, DPR recommends that DCC take regulatory action to prohibit the sale or distribution of cannabis products with any detectable residue of those pesticides. DPR anticipates updating future recommendations to include health-based action levels for these and, as appropriate, other pesticides associated with cannabis cultivation that are identified through enforcement efforts.

Table 2. Pesticides not registered for use in the United States identified though enforcement efforts at cannabis cultivation locations in California

Pesticide	CAS No.
Fenobucarb (BPMC)	3766-81-2
Isoprocarb (MIPC)	2631-40-5
Procymidone	32809-16-8

REVISIONS TO CURRENT ACTION LEVELS

Consolidation of pesticide action levels

DPR is recommending the establishment of specific inhalable/other action levels for additional pesticides and the consolidation of regularly tested pesticides into one list. This represents a transition away from the original two-category system of pesticide testing that was originally proposed by DPR and promulgated with the initial adult use cannabis regulatory framework in 2016. The main impetus for this change is the development of risk-based action levels for all pesticides. However, because of the quantitative method for estimating action levels, some levels may be below detection levels of current analytical equipment. The implementation of these recommendations will be a policy decision left up to DCC.

Through recent enforcement efforts, DPR has become aware of additional pesticides associated with illegal cannabis production that are not registered for use at the federal or state level, for which health-based action levels have not yet been developed. As an interim measure, DPR recommends that DCC take regulatory action to prohibit the sale or distribution of cannabis products with any detectable residue of those pesticides. Future updates from DPR could include health-based action levels for these pesticides and others DCC considers important to better inform analytical detection efforts.

There have been numerous changes both in the regulatory environment and with analytical methodologies that make a two-category system suboptimal. Title 4 CCR § 15719 - Residual Pesticides Testing, currently provides that licensed laboratories shall establish a limit of quantitation (LOQ, or the lowest concentration of a substance in a sample that can be quantified with suitable accuracy and precision) of 0.10 µg/g for all Category I pesticides and shall report when any Category I pesticides are detected above the limit of detection. However, the LOD is not numerically established in regulation. DPR understands that the lack of specific numerical LODs established in regulation may lead to differences in LODs between licensed cannabis testing laboratories in the state. As a result, certain cannabis products may pass pesticide testing where the analytical equipment used was not precise enough to detect the pesticide.

To address this issue, DPR recommends establishing specific action levels for each pesticide. Doing so would require that the same quantitative value for pass/fail be required of all licensed laboratories, thus limiting the possibility of an inadvertent release of cannabis products with unacceptable pesticide residues into the California marketplace.

Updates to Action Levels for Inhalable Cannabis Products

Action levels for all pesticides recommended herein for testing have either been established (for new pesticides) or reviewed/revised (for existing pesticides). Any updates to the CORESTA Guidance Residue Levels (GRLs) for pesticides on tobacco were incorporated. In addition, any changes to pesticides which have regulatory pyrolysis levels of 0.1 µg/g (0.1 parts per million, ppm) established by US EPA were also incorporated.

Updates to Action Levels for Other Cannabis Products

For the update of action levels for other cannabis products, DPR focused on updates to potential human health impacts from edible products, as less data is currently available for topically applied cannabis products. As with inhalable products above, action levels for all pesticides recommended herein for testing have either been established (for new pesticides) or reviewed/revised (for existing pesticides).

In reviewing the action levels for edible cannabis products, DPR reviewed the approved labels and crop use for pesticides to confirm the establishment of US EPA tolerances and allowable use in California. In addition, DPR reviewed any updates to mammalian toxicity data and estimated reference doses for all pesticides. Once the action levels were calculated, DPR reviewed the action levels to ensure they did not exceed established US EPA tolerances for fruit and vegetable crops. Pesticide residues above US EPA tolerances indicate improper use of a pesticide on at least one of the commodities used to produce the cannabis product, and may subject consumers to unnecessarily high levels of pesticides. Therefore, if the action level was higher than the highest US EPA tolerance established for fresh fruit and vegetable crops, then that highest tolerance was substituted as the action level.

A summary of the consolidated list of action levels including additional recommended pesticides and updates to current action levels when warranted are found in Table 4, below. Additionally, Appendix A contains a summary of human health effects of each pesticide. More detail on the recommendations and revisions for action levels, including technical references, can be found in Appendix B. Appendix B also includes updated values for pesticides DPR identified as being lower priority for mandatory testing should DCC retain any of these on future testing requirements.

Refinements for Pesticide Metabolites/Degradates

DPR action levels are calculated based on toxicity data for the unmetabolized and undegraded pesticide (known as the parent compound). However, degradates and/or metabolites for certain pesticides may be more toxic and could potentially be found in manufactured cannabis products due to natural breakdown in the environment or

metabolism by the plant itself. Because of this, DPR is recommending separate action levels for the parent and degradate in these three cases.[7]

1. **Acephate/methamidophos:** DPR is recommending separate action levels for acephate and its toxic metabolite and degradate methamidophos. DPR has specifically included methamidophos as a separate analyte because of its rapid formation both in the environment and in organisms following use/application of acephate and because the toxicity of acephate is attributed to methamidophos formation.

2. **Captan:** Captan metabolizes and rapidly degrades in the environment to tetrahydrophthalimide (THPI), which is detected on crops. US EPA considers THPI to have equivalent toxicity to captan and includes THPI in the residue tolerances established for captan. Cannabis products should be tested for both captan and THPI. If detected, THPI should be converted to captan equivalents and added to the parent to calculate a total captain residue.

3. **Dimethoate/omethoate:** DPR is recommending separate action levels for dimethoate and its toxic metabolite and degradate omethoate. DPR has specifically included omethoate as a separate analyte because of its rapid formation both in the environment and in organisms following use/application of dimethoate and because coexposure of dimethoate with omethoate increases overall health effects from exposure.

Pesticides Identified That May be Deprioritized for Mandatory Testing

To the extent DCC determines it is appropriate to limit the number of pesticides subject to screening, it could consider deprioritizing two pesticides on the existing list, etofenprox and prallethrin (Table 3). DPR reassessed the toxicology data for all Category I pesticides, reviewed the California and/or federal pesticide labels and crop use, and federal tolerance values, as well as data from state or commercially licensed cannabis testing laboratories. DPR identified etofenprox and prallethrin as being a lower priority for residue testing. Pesticide analysis data from post-market sampling of

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[7] US EPA, DPR and the California Department of Food and Agriculture – Center for Analytical Chemistry all rely upon standard methods established for analyzing pesticide residues found in the US Food and Drug Administration (FDA) Pesticide Analytical Manual (PAM) Volumes I and II published by the US Food and Drug Administration (FDA) as a repository of the analytical methods used in FDA laboratories to examine food for pesticide residues for regulatory purposes (40 CFR 180.101 (c)). https://www.fda.gov/food/laboratory-methods-food/pesticide-analytical-manual-pam DPR recommends that certified laboratories consult these methods when developing standard operating procedures and analytical methods to test for pesticide residues in manufactured cannabis products.

consumer cannabis products in California from May – August 2024 provided by a state analytical laboratory. Both compounds are used as insecticides by vector control agencies and are effective mosquitos adulticides used to reduce the spread of West Nile Virus and other vector-borne diseases. They are generally applied as ultra-low volume sprays in low concentrations. These types of applications are designed to maintain the pesticide aloft in the air so that it comes into contact with flying adult insects with use rates of approximately 0.6 ounces per acre treated. The application of these insecticides to control mosquitos is not expected to result in residues of concern. Updated action levels developed herein enable a risk-based approach to testing.

Table 3. Pesticides used for vector control identified as lower priority for mandatory residue testing of legally grown cannabis in California

Pesticide	CAS No.	Current Testing Category
Etofenprox	80844-07-1	Category I
Prallethrin	23031-36-9	Category II

Proposed actions levels for these two pesticides are included in the consolidated list of recommendations as well as in Appendix B of this document.

A summary of all recommendations including actions levels for new pesticides, the revision of action levels for existing pesticides, and inclusion of specific metabolites/degradates or mixtures are provided in Table 4 below. More details concerning the toxicity of tested pesticides and the proposed action levels are found in Appendix A and B, respectively.

Table 4. Proposed Consolidated List of Pesticide Action Levels for Cannabis Testing

Pesticide	**CAS RN**	**Recommendation**	Current Inhalable Cannabis Goods[a] Action Level (µg/g)	**Proposed Inhalable Cannabis Goods Action Level** (µg/g)	Current Other Cannabis Goods[a] Action Level (µg/g)	**Proposed Other Cannabis Goods Action Level** (µg/g)
Abamectin	65195-55-3	Decrease other action level	0.1	0.10	0.3	0.10
Acephate	30560-19-1	Decrease other action level	0.1	0.10	5	0.14
Acequinocyl	57960-19-7	Decrease other action level	0.1	0.10	4	3.7
Acetamiprid	135410-20-7	Increase inhalable action level	0.1	3.0	5	5.0
Aldicarb	116-06-3	Former Category I pesticide	N/A	0.50	N/A	0.014
Azoxystrobin	131860-33-8	Decrease other and increase inhalable action level	0.1	16	40	30
Bifenazate	149877-41-8	No change	0.1	0.10	5	5.0
Bifenthrin	82657-04-3	Increase other action level	3.0	3.0	0.5	1.6
Boscalid	188425-85-6	Increase other action level	0.1	0.10	10	11
Buprofezin	69327-76-0	New pesticide	N/A	0.10	N/A	60
Captan + THPI[b]	133-06-2, 85-40-5	No change	0.7	0.70	5	5.0
Carbaryl	63-25-2	No change	0.5	0.50	0.5	0.50
Carbendazim	10605-21-7	New pesticide	N/A	2.0	N/A	5.0
Carbofuran	1563-66-2	Former Category I pesticide	N/A	0.50	N/A	0.0050
Chlorantraniliprole	500008-45-7	Increase inhalable action level	10	14	40	40
Chlordane[c]	cis-chlordane 5103-71-9, trans-chlordane 5103-74-2	Former Category I pesticide	N/A	0.10	N/A	0.050

Table 4. Proposed Consolidated List of Pesticide Action Levels for Cannabis Testing

Pesticide	**CAS RN**	**Recommendation**	Current Inhalable Cannabis Goods[a] Action Level (µg/g)	**Proposed Inhalable Cannabis Goods Action Level** (µg/g)	Current Other Cannabis Goods[a] Action Level (µg/g)	**Proposed Other Cannabis Goods Action Level** (µg/g)
Chlorfenapyr	122453-73-0	Former Category I pesticide	N/A	0.10	N/A	2.5
Chlorpyrifos	2921-88-2	Former Category I pesticide	N/A	0.50	N/A	0.0050
Clofentezine	74115-24-5	Increase other action level	0.1	0.10	0.5	0.65
Coumaphos	56-72-4	Former Category I pesticide	N/A	0.10	N/A	0.010
Cyfluthrin	68359-37-5	Decrease other action level	2.0	2.0	1	0.59
Cypermethrin	52315-07-8	Decrease other action level	1.0	1.0	1	0.70
Cyprodinil	121552-61-2	New pesticide	N/A	0.10	N/A	50
Dacthal (DCPA)	1861-32-1	New pesticide	N/A	0.10	N/A	0.050
Daminozide	1596-84-5	Former Category I pesticide	N/A	0.10	N/A	0.10
Diazinon	333-41-5	No change	0.1	0.10	0.2	0.15
DDVP (Dichlorvos)	62-73-7	Former Category I pesticide	N/A	0.10	N/A	0.042
Dimethoate	60-51-5	Former Category I pesticide	N/A	0.10	N/A	2.0
Dimethomorph	110488-70-5	Decrease other action level	2.0	2.0	20	13
Ethoprop(phos)	13194-48-4	Former Category I pesticide	N/A	0.10	N/A	0.020
Etofenprox	80844-07-1	Former Category I pesticide	N/A	0.10	N/A	8.0
Etoxazole	153233-91-1	No change	0.1	0.10	1.5	1.5
Fenhexamid	126833-17-8	Increase other action level	0.1	0.10	10	19
Fenoxycarb	72490-01-8	Former Category I pesticide	N/A	0.10	N/A	3.0
Fenpyroximate	111812-58-9	Increase other action level	0.1	0.10	2	4.0

Table 4. Proposed Consolidated List of Pesticide Action Levels for Cannabis Testing

Pesticide	**CAS RN**	**Recommendation**	Current Inhalable Cannabis Goods[a] Action Level (µg/g)	**Proposed Inhalable Cannabis Goods Action Level** (µg/g)	Current Other Cannabis Goods[a] Action Level (µg/g)	**Proposed Other Cannabis Goods Action Level** (µg/g)
Fipronil	120068-37-3	Former Category I pesticide	N/A	0.10	N/A	0.030
Flonicamid	158062-67-0	Increase other action level	0.1	0.10	2	6.0
Fludioxonil	131341-86-1	No change	0.1	0.10	30	25
Fluopyram	658066-35-4	New pesticide	N/A	5.0	N/A	25
Hexythiazox	78587-05-0	Increase other action level	0.1	0.10	2	6.0
Imazalil	35554-44-0	Former Category I pesticide	N/A	0.10	N/A	5.0
Imidacloprid	138261-41-3	Increase inhalable action level	0.1	5.0	3	3.0
Kresoxim-methyl	143390-89-0	No change	0.1	0.10	1	1.0
Malathion	121-75-5	Increase other action level	0.5	0.50	5	8.0
Metalaxyl	57837-19-1	No change	2	2.0	15	15
Methamidophos	10265-92-6	New pesticide	N/A	1.0	N/A	0.049
Methiocarb	2032-65-7	Former Category I pesticide	N/A	0.20	N/A	0.015
Methomyl	16752-77-5	Decrease other action level	1	1.0	0.1	0.075
Methyl parathion	298-00-0	Former Category I pesticide	N/A	0.10	N/A	0.0013
Mevinphos	7786-34-7	Former Category I pesticide	N/A	0.040	N/A	0.017
Monocrotophos	6923-22-4	New pesticide	N/A	0.30	N/A	0.0030
Myclobutanil	88671-89-0	No change	0.1	0.10	9	9.0
Naled	300-76-5	Decrease other action level	0.1	0.10	0.5	0.16
Omethoate	1113-02-6	New pesticide	N/A	0.10	N/A	1.8

Table 4. Proposed Consolidated List of Pesticide Action Levels for Cannabis Testing

Pesticide	**CAS RN**	**Recommendation**	Current Inhalable Cannabis Goods[a] Action Level (µg/g)	**Proposed Inhalable Cannabis Goods Action Level** (µg/g)	Current Other Cannabis Goods[a] Action Level (µg/g)	**Proposed Other Cannabis Goods Action Level** (µg/g)
Oxamyl	23135-22-0	Decrease other action level	0.5	0.50	0.2	0.13
Paclobutrazol	76738-62-0	Former Category I pesticide	N/A	0.10	N/A	5.0
Pentachloronitrobenzene	82-68-8	Increase other action level	0.1	0.10	0.2	1.0
Permethrin	52645-53-1	No change	0.5	0.50	20	20
Phosmet	732-11-6	Decrease other action level	0.1	0.10	0.2	0.070
Piperonyl butoxide	51-03-6	No change	3	3.0	8	8.0
Prallethrin	23031-36-9	Increase other action level	0.1	0.10	0.4	1.0
Propiconazole	60207-90-1	No change	0.1	0.10	20	20
Propoxur	114-26-1	Former Category I pesticide	N/A	0.10	N/A	0.019
Pymetrozine	123312-89-0	New pesticide	NA	1.0	N/A	0.40
Pyraclostrobin	175013-18-0	New pesticide	N/A	0.10	N/A	2.5
Pyrethrins[d]	8003-34-7	No change	0.5	0.50	1	1.0
Pyridaben	96489-71-3	No change	0.1	0.10	3	3.0
Pyrimethanil	53112-28-0	New pesticide	N/A	0.10	N/A	15
Spinetoram	935545-74-7	Decrease other action level	0.1	0.10	3	2.5
Spinosad[e]	131929-60-7, 168316-95-8	Decrease other action level	0.1	0.10	3	2.5
Spiromesifen	283594-90-1	Decrease other action level	0.1	0.10	12	1.9
Spirotetramat	203313-25-1	No change	0.1	0.10	13	13
Spiroxamine	118134-30-8	Former Category I pesticide	N/A	0.10	N/A	0.70

Table 4. Proposed Consolidated List of Pesticide Action Levels for Cannabis Testing

Pesticide	**CAS RN**	**Recommendation**	Current Inhalable Cannabis Goods[a] Action Level (µg/g)	**Proposed Inhalable Cannabis Goods Action Level** (µg/g)	Current Other Cannabis Goods[a] Action Level (µg/g)	**Proposed Other Cannabis Goods Action Level** (µg/g)
Tebuconazole	107534-96-3	Increase inhalable and decrease other action level	0.1	18	2	1.5
Thiacloprid	111988-49-9	Former Category I pesticide	N/A	0.10	N/A	1.0
Thiamethoxam	153719-23-4	No change	5.0	5.0	4.5	4.5
Trifloxystrobin	141517-21-7	No change	0.1	0.10	30	30

[a]As defined in the California Code of Regulations, Title 4, § 15700.

[b]Captan metabolizes and degrades in the environment rapidly into tetrahydrophthalimide (THPI), which is detected on crops. US EPA considers THPI to have equivalent toxicity to the parent captan and US EPA includes THPI in the residue tolerances established for captan. Cannabis products should be tested for both captan and THPI. If detected, THPI should be converted to captan equivalent and added to the parent to calculate a total captain residue.

[c]Chlordane exists as an isomeric mixture in combination with many related chemicals. Sixty to 85% of technical chlordane consists of the stereoisomers cis- and trans-chlordane, the ratio of which depends on the manufacturing process (ATSDR, 2018).

[d]Pyrethrins refer to the insecticidal active ingredients present in pyrethrum extracts obtained from the flowers of the pyrethrum plant, Chrysanthemum cinerariaefolium. Individual pyrethrins in the mixture include pyrethrin I and II, cinerin I and II and jasmolin I and II. The action levels are based on toxicity of the mixture (CAS RN 8003-34-7) and residue testing should be based on measurements of pyrethrin I and II.

[e]Spinosad exists as a two-component mixture comprised of spinosyn A (CAS RN 131929-60-7) and spinosyn D (CAS RN 131929-63-0) in a ratio of approximately 5:1. Obtained from the fermentation of the naturally occurring soil dwelling bacterium Saccharopolyspora spinosa. https://pubchem.ncbi.nlm.nih.gov/#query=Spinosad

CONCLUSIONS

DPR recently reviewed the frequency of detection, toxicity, federal tolerances and hazard identification of all active ingredients from the original list of 66 pesticides provided to BCC in 2017. DPR recommends the addition of 14 pesticides for testing, and the revision of action levels for 31 pesticides currently recommended for testing. DPR also identified two pesticides that may be considered a lower priority for mandatory testing to the extent DCC determines it is appropriate to limit the number of pesticides subject to screening. DPR anticipates updating its recommendations in the future to include health-based action levels for these and, as appropriate, other pesticides associated with cannabis cultivation that are identified through enforcement efforts. The transition away from the Category I/Category II system will allow for a health-based approach for all action levels. In so doing, DPR's recommendations reflect updated data on pesticides commonly used for legal cannabis cultivation in California, up-to-date human health effects and toxicity data, data from testing fresh agricultural commodities, and a health-conservative approach for deriving and establishing action levels for cannabis products. Updated recommendations will be provided on a rolling basis as new information becomes available and as DPR works to develop health-based action levels for newly identified pesticides of concern.

California was the first state to develop action levels on allowable pesticide residues in cannabis products based on public health concerns. The main challenge in developing these analytical values was the evaluation of health risks associated with pesticide exposure from cannabis products because of a lack of residue and consumption data. DPR is currently reviewing data from a commissioned academic study of cannabis consumption in the California marketplace called the California Cannabis Consumption (C3) Survey. DPR anticipates releasing final analysis in 2025. Those data will be incorporated into future refinements to the methodologies DPR uses to establish quantitative action levels for inhalable and other cannabis products.

Pesticides can be legally applied to cannabis under California state law if the active ingredient found in the product is exempt from federal residue requirements and the product is either exempt from registration requirements or registered for a use that is broad enough to include cannabis. More information on DPR's Cannabis Program can be found at https://www.cdpr.ca.gov/docs/cannabis/index.htm. Circumstances involved in illegal cannabis grows are distinct from California's legal cannabis program under the Medicinal and Adult Use Cannabis Regulation and Safety Act (CBC Division 10 § 26000-26325, et seq.) and as regulated by the DCC. Illegal cannabis cultivators often misuse pesticides including ones that are no longer registered for use in California because of impacts to health and the environment. In a parallel effort to address the potential for illegal pesticides entering the California marketplace, and to facilitate further protections for California consumers, DPR is assisting DCC in establishing a pesticide traceback program. This program would be specifically designed for

marketplace cannabis products that test at levels above the recommended action levels herein or that test positive for pesticides that are not registered for use in California. Future goals of this enforcement program would include confirming the origin of the pesticide contamination, including possible field applications.

DPR is committed to the ongoing collaboration with DCC in protecting California consumers. The recommendations herein reflect an ongoing and continuous evaluation of the potential for pesticide exposure from cannabis products to human health. As other pesticides of concern are identified, DPR can assist in providing toxicological information, health impacts, and recommended screening levels as appropriate.

If you have questions regarding this memorandum, please contact Dr. Shelley DuTeaux of DPR's Human Health Assessment Branch at 916-445-4268 or Shelley.DuTeaux@cdpr.ca.gov.

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APPENDIX A.

SUMMARY OF HUMAN HEALTH EFFECTS FROM PESTICIDES DESIGNATED FOR TESTING IN LEGALLY GROWN CANNABIS IN CALIFORNIA

SUMMARY OF HUMAN HEALTH EFFECTS FROM PESTICIDES DESIGNATED FOR TESTING IN LEGALLY GROWN CANNABIS IN CALIFORNIA

NOTE: The human health summaries below are based on publicly available data from the National Institutes of Health, the Department of Pesticide Regulation, and the US Environmental Protection Agency. Unless noted otherwise, the pesticides are not considered by US EPA to be carcinogenic to humans.

Abamectin

Abamectin, also known as avermectin, is a naturally occurring insecticide produced by bacteria. It is used to control insects and mites on agricultural crops and ornamental plants in nursery and greenhouses, for seed treatments, and insect baits. It is registered for use in California and US EPA has established tolerances for abamectin residues in a wide variety of agricultural commodities. Abamectin works by interfering with the insect nervous system causing paralysis, but little is known how it causes toxicity to humans. Human exposure can occur through ingestion, inhalation, and dermal contact. It is highly toxic (Toxicity Category 1) via the oral and inhalation routes if exposed to high enough quantities. Acute toxicity symptoms may include skin irritation local to the site of exposure.

Acephate

Acephate is currently registered for use in California an insecticide used on food crops, citrus trees, golf courses, as a seed treatment, and in commercial or institutional facilities. However, US EPA recently proposed cancelling all uses except for tree injection because of significant risks from residues in drinking water, occupational exposure, and homeowner use. Acephate rapidly breaks down to the toxic byproduct methamidophos (see below) which inhibits the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to acephate can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms include skin irritation or burning, headache, dizziness, blurred vision, nausea, abdominal cramping, vomiting, diarrhea, sweating, muscle twitching, loss of muscle coordination, chest tightness, respiratory failure, seizures, and death. When heated to high temperatures, acephate emits toxic fumes of nitrogen, phosphorous, and sulfur oxides which are hazardous when inhaled. Acephate is considered to be a possible human carcinogen.

Acequinocyl

Acequinocyl is an insecticide used on strawberries, oranges, tangerines, lemons, walnuts, and other food crops. It is registered for use in California and US EPA has established tolerances for acequinocyl residues in a wide variety of agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal

contact. Acequinocyl is known to be a mild skin and eye irritant upon contact. When heated to high temperatures, acequinocyl emits toxic fumes of carbon oxides which are hazardous when inhaled.

Acetamiprid

Acetamiprid is an insecticide with both agricultural and household uses. It is registered for use in California and US EPA has established tolerances for acetamiprid residues in a wide variety of agricultural commodities. Acetamiprid affects the body by mimicking the actions of nicotine and disrupting the nerve's ability to send a normal signal. However, this class of pesticides is more toxic to insects than mammals. Human exposure can still occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, vomiting, diarrhea, abdominal cramping, dizziness, headache, seizures, coma, respiratory failure, hypotension, and even death if exposed to high enough quantities. When heated to high temperatures, acetamiprid emits toxic fumes of hydrogen chloride and carbon and nitrogen oxides which are hazardous when inhaled.

Aldicarb

Aldicarb is a carbamate insecticide and nematicide used in agriculture. It is not currently registered in California, however US EPA has established tolerances for aldicarb residues in a variety of agricultural crops grown elsewhere. Aldicarb affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to aldicarb can occur through ingestion, inhalation, and dermal contact. It is highly toxic through all routes of exposure. Acute toxicity symptoms include headaches, dizziness, blurred vision, nausea, diarrhea, excessive sweating and salivation, muscle weakness and twitching, chest tightness, difficulty breathing, and even death. When heated to high temperatures, aldicarb emits toxic fumes of carbon, nitrogen and sulfur oxides which are hazardous when inhaled.

Azoxystrobin

Azoxystrobin is a fungicide that prevents plants and food crops from becoming infected with fungal diseases. It is registered for use in California and US EPA has established tolerances for azoxystrobin residues in a wide variety of agricultural commodities. Exposure to azoxystrobin can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, dizziness, weakness, and an in irritation or burning of respiratory and gastrointestinal pathways. Dermal contact may result in skin irritation. When heated to high temperatures, azoxystrobin emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Bifenazate

Bifenazate is an insecticide used against mites in greenhouses, nurseries, fields, landscapes, and other non-food crops. It is registered for use in California and US EPA has established tolerances for bifenazate residues in a wide variety of agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include skin and eye irritation if exposed to high enough quantities. When heated to high temperatures, bifenazate emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Bifenthrin

Bifenthrin is a pyrethroid insecticide used in household, agricultural, industrial, and public health settings. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Bifenthrin affects the body by causing a repetitive stimulation of nerves, resulting in muscle spasms and paralysis. Bifenthrin is more toxic to insects than humans because humans metabolize bifenthrin at a faster rate. Exposure to bifenthrin can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include skin tingling, burning, or numbness at the site of exposure, headache, dizziness, blurred vision, irritation of respiratory pathways, sore throat, coughing, chest tightness, nausea, abdominal pain, vomiting, muscle spasms, irregular heartbeat, heart attack, and even death if exposed to high enough quantities. When heated to high temperatures, bifenthrin emits toxic fumes of carbon oxides, hydrogen chloride and hydrogen fluoride, which are hazardous when inhaled. Bifenthrin is classified as a possible human carcinogen.

Boscalid

Boscalid is a fungicide used in vineyards, golf courses, and in fruit and vegetable farms. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. It works by inhibiting the mitochondrial respiration in fungi, but little is known how it causes toxicity to humans. Human exposure can occur through ingestion, inhalation, and dermal contact. When heated to high temperatures, boscalid emits hydrogen chloride gas and toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled. Research has shown boscalid to have suggestive evidence of carcinogenicity in animal studies, but not enough to assess the human carcinogenic potential.

Buprofezin

Buprofezin is an insecticide with agricultural uses as well as uses on ornamental plants grown in greenhouses and nurseries. There are no homeowner uses allowed and it cannot be applied in residential areas. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Buprofezin

works by inhibiting insect growth and reducing the viability of the eggs and is more toxic to insects than mammals. Human exposure can still occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include respiratory tract, eye and skin irritation if exposed to high enough quantities. When heated to high temperatures, buprofezin emits toxic fumes of carbon, nitrogen and sulfur oxides which are hazardous when inhaled.

Captan

Captan is a fungicide used to control a range of fungal diseases in both agricultural and household settings. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Captan is rapidly converted by plants, animals and in the environment into tetrahydrophthalimide (THPI). Captan works by inhibiting the respiration of fungi but little is known how it causes toxicity to humans. Human exposure to captan can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, diarrhea, vomiting, headache, blurred vision, muscle weakness, numbness, chest pain, respiratory system complaints, and skin irritation local to the site of exposure if exposed to high enough quantities. When heated to high temperatures, captan emits hydrogen chloride gas and toxic fumes of carbon, nitrogen, and sulfur oxides which are hazardous when inhaled.

Carbaryl

Carbaryl is an insecticide and acaricide used to control fire ants, fleas, ticks, and spiders in agricultural settings. It is registered for use in California and US EPA has established tolerances for carbaryl residues in a wide variety of agricultural commodities. Carbaryl affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to carbaryl can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include weakness, dizziness, sweating, muscle twitching, loss of coordination, slurred speech, headache, nausea, abdominal cramping, vomiting, diarrhea, seizures, chest tightness, wheezing, difficulty breathing, and death if exposed to at high enough quantities. When heated to high temperatures, carbaryl emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled. Carbaryl is classified by US EPA as likely to be carcinogenic to humans.

Carbendazim

Carbendazim is a fungicide with preventative and curative uses for a variety of fungal diseases. It is used as an industrial biocide, for preservation of materials such as coatings, paints, adhesives, caulks, paper, plastics, and industrial textiles, and for use as a tree injection to control various fungi. It is a metabolite and an environmental degrade of the fungicide thiophanate-methyl. Carbendazim is registered only for non-food uses in California and US EPA has not established tolerances for this compound.

However, humans may still be exposed to carbendazim resides from consuming plant commodities due to the degradation of the parent thiophanate-methyl once applied on crops. Carbendazim works by killing the germination spores, but the mechanism of mammalian toxicity is not clearly defined. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include skin irritation if exposed to high enough quantities. When heated to high temperatures, carbendazim emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled. Carbendazim is classified as a possible human carcinogen.

Carbofuran

Carbofuran is an insecticide and nematicide used extensively on crops against mites, ticks, nematode worms, and various other insects. In 2009, all registered carbofuran products were cancelled in the US. Carbofuran affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to carbofuran can occur through ingestion, inhalation, and dermal contact. It is highly toxic (Toxicity Category I) through all routes of exposure. Acute toxicity symptoms may include skin irritation, headache, dizziness, blurred vision, irritability, short-term memory loss, difficulty concentrating, nausea, vomiting, diarrhea, excessive sweating and salivation, muscle weakness and twitching, aches, convulsions, paralysis, and death. When heated to high temperatures, carbofuran emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Chlorantraniliprole

Chlorantraniliprole is an insecticide used to control a broad spectrum of pests on a range of crops such as potatoes and cotton. It is registered for use in California and US EPA has established tolerances for chlorantraniliprole residues in a wide variety of agricultural commodities. It affects the body by interrupting the normal muscle contraction pathways causing nerve and muscle spasms. Animal studies indicate that chlorantraniliprole has a low toxicity, however, not much is known about its effects in humans other than eye irritation. When heated to high temperatures, chlorantraniliprole emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Chlordane

Chlordane formerly used as an agricultural insecticide and in soil and around buildings to protect from termite infestation. In 2000, all uses and sales of chlordane were banned in the US. Chlordane affects the body by causing an excessive stimulation of the central nervous system. Human exposure to chlordane can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, vomiting, diarrhea, weight loss, headache, confusion, delirium, vision disturbances, tremors, convulsions, seizures, central nervous system depression, coma, and death if exposed to high

enough quantities. When heated to high temperatures, chlordane emits toxic gases and vapors such as hydrogen chloride, chlorine, phosgene, and carbon monoxide which are hazardous when inhaled. Chlordane is a probable human carcinogen.

Chlorfenapyr

Chlorfenapyr is a pro-insecticide which becomes activated once it enters the target pest. It is used on fruiting vegetables and ornamentals in greenhouses, in residential sites, and in medical sites for bed bug treatment. Currently, it is registered for use in California and US EPA has established tolerances for several agricultural commodities. Chlorfenapyr works by disrupting the energy production in insects but little is known how it causes toxicity to humans. Exposure to chlorfenapyr can occur through ingestion, inhalation, and dermal contact. It can be irritating to the eyes. When heated to high temperatures, chlorfenapyr emits toxic vapors of hydrogen chloride, hydrogen fluoride, hydrogen bromide gases, and carbon and nitrogen oxides which are hazardous when inhaled.

Chlorpyrifos

Chlorpyrifos is an organophosphate insecticide with applications on food crops, as well as uses on non-food sites such as ornamental plants in nurseries, golf course turf, as wood treatment, and as an ear tag for cattle. It is registered for only a limited non-food uses in California, however, US EPA allows use on numerous crops in other states. Chlorpyrifos is metabolized to chlorpyrifos oxon which inhibits the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to chlorpyrifos can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, abdominal cramping, diarrhea, dizziness, confusion, blurred vision, sweating, muscle tremors and weakness, loss of control of urine or bowel movements, chest tightness, wheezing, paralysis, cessation of breathing, and death if exposed to at high enough quantities. When heated to high temperatures, chlorpyrifos emits hydrogen chloride gas and toxic fumes of carbon, nitrogen, and phosphorous oxides which are hazardous when inhaled.

Clofentezine

Clofentezine is an acaricide used against mites on crops and ornamental plants in greenhouses and nurseries. It is registered for use in California and US EPA has established tolerances on a variety of agricultural commodities. Clofentezine works by killing the mite’s larva. It can be irritating to eye and skin, but little else is known about any human health effects. When heated to high temperatures, clofentezine emits toxic fumes of carbon, nitrogen, phosphorus and sulfur oxides, and hydrogen chloride gas, which are toxic when inhaled. Clofentezine is considered to be a possible human carcinogen.

Cyfluthrin

Cyfluthrin is a pyrethroid insecticide used to control ants, cockroaches, termites, fleas, mosquitos, and flies. It is registered for use in California and US EPA has established tolerances in a wide variety of agricultural commodities. Cyfluthrin affects the body by causing a repetitive stimulation of nerves, resulting in muscle spasms and paralysis. Cyfluthrin is less toxic to humans than insects because humans metabolize cyfluthrin at a faster rate. Exposure to cyfluthrin can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include burning, itching, or tingling of the skin, headache, dizziness, blurred vision, nausea, vomiting, fatigue, sweating, chest tightness, difficult breathing, muscle twitching, convulsions, seizures, coma, and even death if exposed to high enough quantities. When heated to high temperatures, cyfluthrin emits hydrogen toxic fumes of hydrogen chloride, hydrogen fluoride, and carbon and nitrogen oxides which are hazardous when inhaled.

Cypermethrin

Cypermethrin is a pyrethroid insecticide used to control a broad spectrum of pests including weevils, caterpillars, beetles, and flies. It is registered for use in California and US EPA has established tolerances for this compound on a wide variety of agricultural commodities. Cypermethrin affects the body by causing a repetitive stimulation of nerves, resulting in muscle spasms and paralysis. However, it is more toxic to insects than humans because humans metabolize cypermethrin at a faster rate. Exposure to cypermethrin can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include a burning, itching, or tingling sensation of the skin, headache, blurred vision, fatigue, nausea, vomiting, chest tightness, coughing, congestion, muscle twitching, convulsions, seizures, coma, and even death if exposure is sufficiently high. When heated to high temperatures, cypermethrin emits toxic fumes of cyanide, carbon and nitrogen oxides, and hydrogen chloride gas which are hazardous when inhaled. Cypermethrin is a possible human carcinogen.

Cyprodinil

Cyprodinil is a fungicide with agricultural uses as well as uses in and around residential and industrial buildings, recreational areas and athletic fields. It is registered for use in California and US EPA has established tolerances for cyprodinil residues in a variety of agricultural commodities. Cyprodinil works by inhibiting the amino acid biosynthesis in fungi. Human exposure can still occur through ingestion, inhalation, and dermal contact. It can be irritating to skin, eyes and the respiratory tract, and can cause allergic skin reactions. When heated to high temperatures, cyprodinil emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Dachtal (DCPA)

Dachtal is an herbicide used to controls grasses and weeds in a variety of agricultural crops and ornamental plants. It is currently registered for use in California and US EPA has established tolerances for dacthal residues in a variety of agricultural commodities. In 2023, US EPA published concerns about dacthal affecting developing fetuses and is considering additional control measures. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include skin and eye irritation if exposed to high enough quantities. When heated to high temperatures, dachtal emits toxic fumes of carbon oxides and hydrogen chloride gas, which are hazardous when inhaled. Dachtal is classified as a possible human carcinogen based on evidence of thyroid and liver tumors in rodents.

Daminozide

Daminozide is a chemical known as a plant regulator. It is only registered for non-food uses on ornamental plants grown greenhouses and nurseries in California. There are no US EPA tolerances for this compound. Human exposure to daminozide can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include diarrhea, convulsions, inflammation of the gastrointestinal tract, irritation of respiratory tract, liver and kidney damage, drooping of upper eyelid due to paralysis, and in cases of sever poisoning, coma. When heated to high temperatures, daminozide emits toxic carbon and nitrogen oxides which are hazardous when inhaled. Daminozide is classified as a probable human carcinogen.

Diazinon

Diazinon is an insecticide used in agriculture to control insects on a variety of fruit, vegetable, nut, and field crops. It is also used in veterinary medicine. It is registered for use in California and US EPA has established tolerances on a wide variety of agricultural commodities. Diazinon affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to diazinon can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms include watery eyes, runny nose, drooling, headache, blurred vision, nausea, diarrhea, abdominal cramping, vomiting, muscle twitching, coughing, chest tightness, difficulty breathing, seizures, convulsions, and coma if exposed to high enough quantities. When heated to high temperatures, diazinon emits hydrogen cyanide and toxic fumes of phosphorous sulfur, and nitrogen oxides which are hazardous when inhaled.

DDVP (Dichlorvos)

DDVP or dichlorvos is an insecticide used for fumigation, a method of pest control that completely fills an area with gaseous pesticides to suffocate the pests within. It is

registered for use in California and US EPA has established tolerances on several agricultural commodities. Dichlorvos affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, drowsiness, confusion, restlessness, aching eyes, small pupils, sweating, tearing, gritting of teeth, nausea, abdominal cramping, diarrhea, vomiting, muscle tremors and weakness, chest tightness, wheezing, a bluish discoloration of the skin as a result of lack of oxygen in the blood, convulsions, paralysis, coma, and death if exposed to high enough quantities. When heated to high temperatures, dichlorvos emits toxic gases and vapors including carbon and phosphorus oxides, hydrogen chloride, and phosgene, which are hazardous when inhaled.

Dimethoate

Dimethoate is an insecticide used against a variety of insects and mites. It is registered in California and US EPA has established tolerances on a wide variety of agricultural commodities. Dimethoate inhibits the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. In insects and mammals dimethoate is converted to its oxon metabolite omethoate, which is more toxic than the parent compound. Human exposure to dimethoate and omethoate can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, dizziness, weakness, anxiety, and blurred vision, nausea, abdominal cramps, vomiting, sweating, and low blood pressure, diarrhea, pinpoint pupils, chest tightness, difficulty breathing, cardiac irregularities, convulsion, coma, and death if exposed to high enough quantities. When heated to high temperatures, dimethoate emits toxic fumes of carbon, nitrogen, phosphorous, and sulfur oxides which are hazardous when inhaled. Dimethoate is considered a possible human carcinogen.

Dimethomorph

Dimethomorph is a fungicide used primarily on agricultural crops for its curative and preventative properties against fungal diseases. It is registered for use in California and US EPA has established tolerances on several agricultural commodities. Its fungicidal mode of action is through inhibition of sterol biosynthesis. It is highly toxic to aquatic species, but little is known about its effects in humans. When heated to high temperatures, dimethomorph emits toxic fumes of carbon and nitrogen oxides, hydrogen chloride gas which are hazardous when inhaled.

Ethoprop(hos)

Ethoprop is an organophosphate insecticide and nematicide used on food crops. It is registered for use in California and US EPA has established tolerances on multiple

commodities. It is a Restricted Material in California according to Title 3 of the California Code of Regulations, section 6400, specifically for applications to turf. Ethoprop affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to ethoprop can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, blurred vision, nausea, vomiting, diarrhea, burning/itching eyes, fever, muscle twitching and weakness, chest tightness, difficulty breathing, convulsions, seizure, coma, and even death if exposed to high enough quantities. When heated to high temperatures, ethoprop emits toxic fumes of carbon, phosphorus and sulfur oxides, which are hazardous when inhaled. Ethoprop is classified as likely to be carcinogenic to humans.

Etoxazole

Etoxazole is an acaricide and insecticide used to control mites and insects in various agricultural crops. It is registered for use in California and US EPA has established tolerances on a wide variety of agricultural commodities. It works by inhibiting the chitin biosynthesis in insects, but little is known how it causes toxicity to humans. Animal studies indicate that etoxazole has a low mammalian toxicity, however, exposure can still occur through ingestion, inhalation, and dermal contact. When heated to high temperatures, etoxazole emits fluorine compounds and toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Fenhexamid

Fenhexamid is a fungicide used primarily on fruit and ornamental plants. It is registered for use in California and US EPA has established tolerances for a variety of agricultural commodities. Fenhexamid prevents fungi from infecting plants by inhibiting spore germination and mycelial growth. It can cause eye and skin irritation, but little else is known about any impacts to human health. When heated to high temperatures fenhexamid may emit hydrogen cyanide as well as oxides of nitrogen, carbon and chlorine which are hazardous when inhaled.

Fenoxycarb

Fenoxycarb is a carbamate ester derivative that acts as an insect growth regulator and was used in the past as an insecticide and miticide. In 2010 US EPA canceled all uses of fenoxycarb. It is not registered in California and there are no US EPA tolerances for this compound. Fenoxycarb disrupts the development of the insects by preventing juveniles from reaching adult stage, but little is known how it causes toxicity to humans. Exposure to fenoxycarb can occur through ingestion, inhalation, and dermal contact. When heated to high temperatures, fenoxycarb decomposes to carbon and nitrogen oxides which are hazardous when inhaled. Fenoxycarb is classified as a probable human carcinogen.

Fenpyroximate

Fenpyroximate is an insecticide primarily used on vegetable crops. It is registered for use in California and US EPA has established tolerances for a variety of agricultural commodities. Fenpyroximate prevents crop damage by interfering with mite metabolism. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include eye irritation, conjunctivitis, difficulty breathing, abdominal cramping, diarrhea, and death if exposed to high enough quantities. When heated to high temperatures fenpyroximate emits hydrogen cyanide and oxides of carbon and nitrogen which are hazardous when inhaled.

Fipronil

Fipronil is an insecticide used on crops, livestock, and domestic animals. It is registered for use in California and US EPA has established tolerances for fipronil on several agricultural commodities. Fipronil affects the body by causing an excessive stimulation of the central nervous system. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include agitation, headache, dizziness, blurred vision, sweating, nausea, abdominal cramping, vomiting, diarrhea, respiratory complaints, muscle spasms and weakness, seizures, and death if exposed to high enough quantities. When heated to high temperatures fipronil emits hydrogen fluoride, hydrogen chloride, hydrogen cyanide, and oxides of carbon, nitrogen and sulfur which are hazardous to inhale. Fipronil is considered to be a possible human carcinogen.

Flonicamid

Flonicamid is an insecticide primarily used on fruits and vegetables. It is registered for use in California and US EPA has established tolerances for a variety of agricultural commodities. Flonicamid prevents crop damage by interfering with the insect nervous system. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, vomiting, diarrhea, headache, blurred vision, dizziness, chest tightness, difficulty breathing, seizures, and coma if exposed to high enough quantities. When heated to high temperatures flonicamid emits hydrogen cyanide and oxides of carbon and nitrogen which are hazardous to inhale.

Fludioxonil

Fludioxonil is a fungicide used on lawn, turf, and various fruit and vegetable crops. Fludioxonil is registered for use in California and US EPA has established tolerances for residues on a variety of agricultural commodities. Fludioxonil prevents fungi from infecting plants by inhibiting fungal growth. Human exposure can occur through ingestion, inhalation, and dermal contact and it can cause eye and skin irritation. When

heated to high temperatures fludioxonil emits hydrogen fluoride and hydrogen cyanide as well as oxides of nitrogen, carbon and chlorine which are hazardous when inhaled.

Fluopyram

Fluopyram is a fungicide and nematicide used in agriculture. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Fluopyram works by inhibiting the cellular respiration of fungi. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include shortness of breath and wheezing if exposed to high enough quantities. When heated to high temperatures, fluopyram emits toxic fumes of carbon and nitrogen oxides, hydrogen chloride and hydrogen fluoride gases, which are hazardous when inhaled.

Hexythiazox

Hexythiazox is an insecticide used on cotton, fruit, and vegetables. It is registered for use in California and US EPA has established tolerances for hexythiazox residues on a variety of agricultural commodities. Hexythiazox prevents crop damage by interfering with mite development and growth. Human exposure can occur through ingestion, inhalation, and dermal contact and it can cause eye and skin irritation. When heated to high temperatures hexythiazox emits hydrogen cyanide, hydrogen sulfide, as well as oxides of nitrogen, carbon and sulfur which are hazardous when inhaled. Hexythiazox is considered to be a possible human carcinogen

Imazilil

Imazalil is a fungicide used primarily on citrus, bananas, wheat, and barley. It is registered for use in California and US EPA has established tolerances for a variety of agricultural commodities. Imazilil prevents fungi from infecting plants by interfering with fungal metabolism. Human exposure can occur through ingestion, inhalation, and dermal contact and it can cause eye and skin irritation and irritation of the upper airways. When heated to high temperatures, imazilil emits hydrogen cyanide, hydrogen chloride, and oxides of nitrogen, carbon and chlorine which are hazardous when inhaled. Imazalil is a likely human carcinogen.

Imidacloprid

Imidacloprid is an insecticide extensively used in agriculture, in residential and commercial buildings, turf, landscape gardens, and in veterinary medicine. It is registered for use in California and US EPA has established tolerances on a wide variety of agricultural commodities. Imidacloprid affects the body by mimicking the actions of nicotine and disrupting the nerve’s ability to send a normal signal. However, this class of pesticides is more toxic to insects than mammals. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may

include skin and eye irritation, dizziness, confusion, fatigue, excessive salivation or drooling, vomiting, fever, difficulty breathing, muscle twitching, and loss of motor control if exposed to high enough quantities. When heated to high temperatures imidacloprid emits hydrogen cyanide, hydrogen chloride, and oxides of nitrogen, carbon and chlorine which are hazardous when inhaled.

Kresoxim-methyl

Kresoxim-methyl is a fungicide used on agricultural crops and ornamental plants. It is registered in for use in California and US EPA has established tolerances on multiple commodities. Kresoxim-methyl blocks fungal growth by disrupting mitochondrial respiration and suppressing spore germination and host infection, but little is known how it causes toxicity to humans. Exposure to kresoxim-methyl can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include eye irritation if exposed to high enough quantities. When heated to high temperatures, kresoxim-methyl emits toxic vapors of carbon and nitrogen oxides, which are hazardous when inhaled. Kresoxim-methyl is classified by US EPA as likely to be carcinogenic in humans.

Malathion

Malathion is an insecticide with applications in food crops, public health programs, and household products. It is registered for use in California and US EPA has established tolerances for several agricultural commodities. Malathion is metabolized to malaoxon which affects the body's ability to breakdown acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to malathion can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, abdominal cramping, diarrhea, vomiting, muscle twitching and cramping, weakness, difficulty breathing, and a slowed heart rate if exposed to high enough quantities. When heated to high temperatures, malathion emits toxic fumes of carbon, sulfur, phosphorous, and nitrogen oxides which are hazardous when inhaled.

Metalaxyl

Metalaxyl is a fungicide used primarily in the agricultural setting that controls a variety of fungal diseases. It is a restricted material in California, meaning that only certain licensed pesticide applicators may buy and apply it and that there are specific restrictions on how much and where it can be applied. Metalaxyl inhibits protein synthesis in fungi, but little is known how it causes toxicity to humans. Human exposure to metalaxyl can occur through ingestion, inhalation, and dermal contact. When heated

to high temperatures, metalaxyl emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Methamidophos

Methamidophos is an insecticide used in the past on food crops. It is the major metabolite and environmental degradate of the insecticide acephate. In 2009, all registered products in the US were cancelled. However, humans may be exposed to methamidophos resides due to the degradation of the parent acephate once applied on crops or in residential sites. Methamidophos is a Restricted Material in California per the Title 3 of the California Code of Regulations, section 6400. Methamidophos affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to methamidophos can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms include skin irritation or burning, headache, dizziness, blurred vision, nausea, abdominal cramping, vomiting, diarrhea, sweating, muscle twitching, loss of muscle coordination, chest tightness, respiratory failure, seizures, and death. When heated to high temperatures, methamidophos emits toxic fumes of carbon, nitrogen, phosphorous, and sulfur oxides which are hazardous when inhaled.

Methiocarb

Methiocarb is a carbamate insecticide, molluscicide, and miticide used on ornamentals in nurseries and greenhouses to control snails, slugs, mites, aphids, thrips, sowbugs, and fungus gnats. It is not registered for use in California and US EPA has not established tolerances for this compound. Methiocarb affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to methiocarb can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, dizziness, small pupils, watering of eyes, skin irritation, nausea, vomiting, diarrhea, irritation of respiratory pathways, shortness of breath, coughing, muscle twitching and weakness, convulsions, seizures, coma, and even death if exposed to high enough quantities. When heated to high temperatures, methiocarb emits toxic fumes of carbon, nitrogen and sulfur oxides which are hazardous when inhaled.

Methomyl

Methomyl is an insecticide used to control a wide range of foliar and soil-borne insects. It is registered as a restricted use material in California, meaning that only certain licensed pesticide applicators may buy and apply it and that there are specific restrictions on how much and where it can be applied. US EPA has established tolerances for this compound on several agricultural commodities. Methomyl affects the

body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to methomyl can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, blurred vision, nausea, abdominal cramping, vomiting, diarrhea, excessive sweating, muscle twitching, difficulty breathing, convulsions, coma, and death if exposed to high enough quantities. When heated to high temperatures, methomyl emits toxic fumes of nitrogen which are hazardous when inhaled.

Methyl parathion

Methyl parathion is an organophosphorus insecticide and acaricide. It was one of the most extensively used pesticides in agriculture and non-agricultural settings until 2011 when all registered products in the US were cancelled. Methyl parathion affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to methyl parathion can occur through ingestion, inhalation, and dermal contact. It is highly toxic (Toxicity Category I) through all routes of exposure. Acute toxicity symptoms may include nausea, abdominal cramping, diarrhea, dizziness, confusion, blurred vision, sweating, muscle tremors, loss of control of urine or bowel movements, chest tightness, wheezing, paralysis, cessation of breathing, and death. When heated to high temperatures, methyl parathion emits hydrogen chloride gas and toxic fumes of carbon, nitrogen, sulfur and phosphorous oxides, which are hazardous when inhaled.

Mevinphos

Mevinphos is an insecticide used in the past on various vegetables, alfalfa, fruits, and nuts. In 1994, all registered products in the US were cancelled. Mevinphos affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to mevinphos can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, blurred vision, tearing, weakness, fatigue, disorientation, cramps, nausea, diarrhea, chest tightness, wheezing, coughing, difficulty breathing, convulsions, paralysis, and death. When heated to high temperatures, mevinphos emits toxic fumes of phosphoric acid and carbon monoxide which are hazardous when inhaled.

Monocrotophos

Monocrotophos is an insecticide used in the past on food crops. In 1989, all registered products in the US were cancelled, however, it is still used in some developing countries. Monocrotophos affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged

stimulation of nerves and muscles. Human exposure to monocrotophos can occur through ingestion, inhalation, and dermal contact. It is highly toxic (Toxicity Category I) through all routes of exposure. Acute toxicity symptoms include skin irritation or burning, headache, dizziness, blurred vision, nausea, abdominal cramping, vomiting, diarrhea, sweating, muscle twitching, loss of muscle coordination, chest tightness, respiratory failure, seizures, and death. When heated to high temperatures, monocrotophos emits toxic fumes of carbon, nitrogen and phosphorous oxides which are hazardous when inhaled.

Myclobutanil

Myclobutanil is a fungicide used to control a variety of fungal diseases. It is registered as a restricted use pesticide in California, meaning that only certain licensed pesticide applicators may buy and apply it and that there are specific restrictions on how much and where it can be applied. US EPA has established tolerances for this compound on several agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include irritation of the eyes, nose, and throat, coughing, and nausea if exposure if exposed to high enough quantities. When heated to high temperatures, myclobutanil emits toxic fumes of hydrogen cyanide, which are hazardous when inhaled.

Naled

Naled is an insecticide most commonly used for mosquito control and against biting flies and other crop-damaging insects. It is registered as a restricted use insecticide in California, meaning that only certain licensed pesticide applicators may buy and apply it and that there are specific restrictions on how much and where it can be applied. US EPA has established tolerances for this compound on several agricultural commodities. Naled affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to naled can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms include headache, blurred vision, nausea, abdominal cramping, diarrhea, muscle twitching, chest tightness, difficulty breathing, convulsions, paralysis, and death if exposed to high enough quantities. When heated to high temperatures, naled emits toxic fumes of hydrogen chloride gas and bromide, chloride, and phosphorus oxides which are hazardous when inhaled.

Omethoate

In insects and mammals, dimethoate is converted to its oxon metabolite omethoate, which is more toxic than the parent compound. Not only is omethoate is the major metabolite of dimethoate, but it is also the primary toxic environmental degradate. It is frequently found on agricultural commodities treated with dimethoate and, therefore, can be consumed separately from the parent compound. Also, human health effects can be

increased by the coexposure of dimethoate and its metabolite/degradate omethoate together. Please refer to the dimethoate health summary above for potential health effects and heating decomposition information.

Oxamyl

Oxamyl is an insecticide commonly used in agriculture and on ornamental plants. It is registered as a restricted use pesticides, meaning that only certain licensed pesticide applicators may buy and apply it and that there are specific restrictions on how much and where it can be applied. US EPA has established tolerances on a variety of agricultural commodities. Oxamyl affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Exposure to oxamyl can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headaches, dizziness, blurred vision, nausea, diarrhea, excessive sweating and salivation, muscle weakness and twitching, chest tightness, difficulty breathing, and death if exposed to high enough quantities. When heated to high temperatures, oxamyl emits toxic fumes of sulfur and nitric oxides which are hazardous when inhaled.

Pentachloronitrobenzene

Pentachloronitrobenzene is fungicide primarily used on lawns and agricultural crops. It is registered for use in California and US EPA has established tolerances for pentachloronitrobenzene residues in a wide variety of agricultural commodities. Exposure to pentachloronitrobenzene can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms include skin sensitization and irritation, headache, dizziness, nausea, diarrhea, vomiting, fatigue, muscle weakness, convulsions, and coma if exposed to high enough quantities. When heated to high temperatures, pentachloronitrobenzene emits toxic fumes of chlorine, phosgene, and carbon and nitrogen oxides which are hazardous when inhaled. Pentachloronitrobenzene is a possible human carcinogen.

Permethrin

Permethrin is an insecticide used in public health mosquito control programs, on food crops, lawns, structures and buildings, and even on clothing as an insect repellent. It is registered for use in California and US EPA has established tolerances for permethrin residues in a wide variety of agricultural commodities. Permethrin affects the body by causing a repetitive stimulation of nerves, resulting in muscle spasms and paralysis. Permethrin is less toxic to humans than insect because it is metabolized at a faster rate. Exposure to permethrin can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include tinging, burning, or itching at the site of skin contact, sore throat, headache, dizziness, nausea, vomiting, abdominal cramping, chest tightness, difficulty breathing, and death if exposed to high enough quantities. When

heated to high temperatures, permethrin emits toxic fumes of hydrogen chloride which is hazardous when inhaled. Permethrin is a likely human carcinogen.

Phosmet

Phosmet is an insecticide used to control various larvae, aphids, and other pests. It is registered for use in California and US EPA has established tolerances for a variety of agricultural commodities. Phosmet affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to phosmet can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include headache, dizziness, blurred vision, disorientation, nausea, abdominal cramping, diarrhea, vomiting, drooling, pinpoint pupils, muscle twitching, weakness, chest tightness, difficulty breathing, convulsions, coma, and death if exposed to high enough quantities. When heated to high temperatures, phosmet emits toxic fumes of nitrogen phosphorous, and sulfur oxides which are hazardous when inhaled.

Piperonyl butoxide

Piperonyl butoxide is a chemical that does not have any insecticidal properties but that acts as a synergist that increases the effectiveness of pyrethrin and pyrethroid insecticides. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Piperonyl butoxide affects the body by inhibiting enzymes that play a role in the natural break down of some insecticides that enter the body. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include tearing, drooling, runny nose, congestion, and difficulty breathing if exposed to high enough quantities. When heated to high temperatures, piperonyl butoxide emits acrid smoke and irritating fumes that are hazardous when inhaled. Piperonyl butoxide is a possible human carcinogen.

Propiconazole

Propiconazole is a fungicide used commonly in agricultural crops and can also be used as a wood preservative that prevents decay. It is registered for use in California and US EPA has established tolerances for propiconazole residues in a wide variety of agricultural commodities. Human exposure to propiconazole can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, vomiting, abdominal cramping, diarrhea, blurred vision, dizziness, headache, disorientation, seizures, and heart irregularities if exposed to high enough quantities. When heated to high temperatures, propiconazole emits toxic fumes of nitrogen oxide and hydrogen chloride which are hazardous when inhaled. Propiconazole is a possible human carcinogen.

Propoxur

Propoxur is an insecticide used to control cockroaches, flies, mosquitos, and lawn and turf insects. It is registered for use in California for non-food uses. Propoxur affects the body by inhibiting the breakdown of acetylcholine, a chemical responsible for nerve transmission within the body, causing a prolonged stimulation of nerves and muscles. Human exposure to propoxur can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms include nausea, vomiting, abdominal cramping, blurred vision, sweating, loss of coordination, muscle twitching, chest tightness, coughing, wheezing, convulsions, coma, and death if exposed to high enough quantities. When heated to high temperatures, etofenprox emits toxic fumes of nitrogen oxide and methyl isocyanate which are hazardous when inhaled. Propoxur is a probable human carcinogen.

Pymetrozine

Pymetrozine is an insecticide with agricultural uses as well as uses on ornamental plants grown in greenhouses. It is registered for use in California and US EPA has established tolerances for a variety of agricultural commodities. Pymetrozine is a neuroactive chemical affecting the nerve-muscle interaction. This class of pesticides is more toxic to insects than mammals. Human exposure can still occur through ingestion, inhalation, and dermal contact and it causes skin and eye irritation. When heated to high temperatures, pymetrozine emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled. Pymetrozine is classified as a likely human carcinogen.

Pyraclostrobin

Pyraclostrobin is a fungicide with agricultural uses as well as uses on residential and commercial ornamentals, landscape gardens, and as a seed treatment for agricultural crops. It is registered for use in California and US EPA has established tolerances for a variety of agricultural commodities. Pyraclostrobin works by inhibiting spore germination, growth, and sporulation of fungi. The mechanism of mammalian toxicity is not clearly defined. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include skin and eye irritation, intestinal disturbance, and wheezing if exposed to high enough quantities. When heated to high temperatures, pyraclostrobin emits toxic fumes of carbon and nitrogen oxides, hydrogen chloride gas, which are hazardous when inhaled.

Pyrethrins

Pyrethrins are a class of pesticides commonly used to control mosquitos, fleas, flies, moths, and ants. They are registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Pyrethrins affect the body by causing a repetitive stimulation of nerves, resulting in muscle spasms and paralysis.

Exposure to pyrethrins can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include burning, itching, or tingling of the skin, headache, nausea, vomiting, diarrhea, chest tightness, difficulty breathing, muscle twitching, seizures, and paralysis, if exposed to high enough quantities. When heated to high temperatures, pyrethrins emit acrid smoke and irritating fumes, which can be hazardous when inhaled.

Pyridaben

Pyridaben is an insecticide used against thrips, mites, aphids, and leafhoppers. It is registered for use in California and US EPA has established tolerances for many agricultural commodities. Exposure to pyridaben can occur through ingestion, inhalation, and dermal contact and it can cause skin irritation. When heated to high temperatures, pyridaben emits toxic fumes of hydrogen chloride and carbon, sulfur, and nitrogen oxides which are hazardous when inhaled.

Pyrimethanil

Pyrimethanil is a fungicide with agricultural uses but not residential uses. It is registered for use in California and US EPA has established tolerances for pyrimethanil residues in a variety of agricultural commodities. Pyrimethanil works by inhibiting amino acid biosynthesis in fungi but the mechanism of mammalian toxicity is not clearly defined. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include eye irritation, headache, nausea, and difficulty breathing if exposed to high enough quantities. When heated to high temperatures, pyrimethanil emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Spinetoram

Spinetoram is an insecticide used against common pests including moths, thrips, and slugs. It is registered for use in California and US EPA has established tolerances for many agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal contact and it can cause skin irritation. When heated to high temperatures, spinetoram emits toxic fumes which are hazardous when inhaled.

Spinosad

Spinosad is a naturally-occurring pesticide produced by bacteria that can be used to control thrips, leafminers, spider mites, mosquitos, ants, and fruit flies. It is registered for use in California and US EPA has established tolerances for many agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include skin irritation and vomiting. When heated to high temperatures, spinosad emits toxic fumes of carbon and nitrogen oxides which are hazardous when inhaled.

Spiromesifen

Spiromesifen is an insecticide primarily used against mites and flies. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include to skin irritation and vomiting. When heated to high temperatures, spiromesifen emits toxic fumes of carbon oxides which are hazardous when inhaled. Spiromesifen is classified as a possible human carcinogen.

Spirotetramat

Spirotetramat is an insecticide used to control a wide range of sucking insects on agricultural crops. It is registered for use in California and US EPA has established tolerances for a wide variety of agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal contact. A lack of toxicity data makes it difficult to determine the acute effects that spirotetramat exposure may have on human health. When heated to high temperatures, spirotetramat emits toxic fumes of hydrogen cyanide and carbon and nitrogen oxides which are hazardous when inhaled.

Spiroxamine

Spiroxamine is a fungicide used in agriculture to control common fungal diseases on cereals and fruit. It is not registered for use in California and US EPA cancelled all tolerances for this compound in 2012. Exposure to spiroxamine can occur through ingestion, inhalation, and dermal contact. Animal studies indicate that spiroxamine has a low mammalian toxicity, however data on human toxicity is limited. When heated to high temperatures, spiroxamine emits toxic fumes of hydrogen cyanide and carbon and nitrogen oxides which are hazardous when inhaled.

Tebuconazole

Tebuconazole is a fungicide used against foliar diseases in cereals and other agricultural crops. It is registered for use in California and US EPA has established tolerances for tebuconazole residues in a wide variety of agricultural commodities. Human exposure can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include skin irritation, sedation, and muscle twitching and incoordination. When heated to high temperatures, tebuconazole emits toxic fumes of hydrogen chloride and nitrogen oxides which are hazardous when inhaled. Tebuconazole is classified as a possible human carcinogen.

Thiacloprid

Thiacloprid is an insecticide used to control aphids, beetles, moths, and other insects. It is not currently registered for use in California although US EPA has established

tolerances for thiacloprid residues in select agricultural commodities grown in other states or countries. Thiacloprid affects the body by mimicking the actions of nicotine and disrupting the nerve's ability to send a normal signal. However, this class of pesticides are more toxic to insects than mammals. Human exposure to thiacloprid can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms may include nausea, vomiting, abdominal cramping, diarrhea, dizziness, headache, muscle twitching, chest tightness, difficulty breathing, seizures, and death, if exposed to high enough quantities. When heated to high temperatures, thiacloprid emits toxic fumes of hydrogen chloride, hydrogen cyanide, and carbon, nitrogen, and sulfur oxides which are hazardous when inhaled. Thiacloprid is considered to be a likely human carcinogen.

Thiamethoxam

Thiamethoxam is an insecticide used to control thrips, leafhoppers, worms, beetles, ants, and crickets. It is registered for use in California and US EPA has established tolerances for thiamethoxam residues in a wide variety of agricultural commodities Thiamethoxam affects the body by mimicking the actions of nicotine and disrupting the nerve's ability to send a normal signal. However, this class of pesticides are more toxic to insects than mammals. Exposure to thiamethoxam can occur through ingestion, inhalation, and dermal contact. Acute toxicity symptoms include nausea, vomiting, abdominal cramping, diarrhea, headache, blurred vision, chest tightness, difficulty breathing, muscle twitching, seizures, and death, if exposed to high enough quantities. When heated to high temperatures, thiamethoxam emits toxic fumes of hydrogen chloride gas, carbon, nitrogen and sulfur oxides, which are hazardous when inhaled.

Trifloxystrobin

Trifloxystrobin is a fungicide with preventative and curative uses for a variety of fungal diseases. It is registered for use in California and US EPA has established tolerances for trifloxystrobin residues in a wide variety of agricultural commodities. Human exposure to trifloxystrobin can occur through ingestion, inhalation, or dermal contact. Acute toxicity symptoms may include headache, dizziness, weakness, and an in irritation or burning of respiratory and gastrointestinal tract if exposed to high enough quantities. Dermal contact may cause skin irritation. When heated to high temperatures, trifloxystrobin emits toxic fumes of hydrogen cyanide, hydrogen fluoride, and carbon and nitrogen oxides which are hazardous when inhaled.

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APPENDIX B.

DETAILED LIST OF REVISED PESTICIDE ACTION LEVELS FOR LEGALLY GROWN CANNABIS IN CALIFORNIA

Table B. Detailed list of revised pesticide action levels for legally grown cannabis in California

Pesticides (CAS RN)	**POD**[a] (mg/kg/day)	**UF_{TOTAL}**[b]	**RfD**[c] (mg/kg/day)	**Tolerance**[d] (ppm)	**Risk-based Action Level**[e] (ppm)	**Proposed Action Level for Other Goods**[f] (ppm)	**Proposed Action Level for Inhalable Goods**[g] (ppm)	**RfD Reference**
Abamectin (71751-41-2)	0.25	100	0.0025	0.1	0.13	0.10	0.10	US EPA, 2018a
Acephate (30560-19-1)	0.272	100	0.003	10	0.14	0.14	0.10	US EPA, 2023a
Acequinocyl (57960-19-7)	7.3	100	0.073	4	3.65	3.7	0.10	US EPA, 2021a
Acetamiprid (135410-20-7)	10	100	0.1	15	5.0	5.0	3.0	US EPA, 2020a
Aldicarb* (116-06-3)	0.013	48	0.00027	0.5	0.014	0.014	0.50	US EPA, 2021b
Azoxystrobin (131860-33-8)	200	300	0.67	30	33	30	16	US EPA, 2023b
Bifenazate (149877-41-8)	10	100	0.1	7	5.0	5.0	0.10	US EPA, 2014a
Bifenthrin (82657-04-3)	3.1	100	0.031	4	1.6	1.6	3.0	US EPA, 2020b
Boscalid (188425-85-6)	22	100	0.22	70	11	11	0.10	US EPA, 2021c
Buprofezin** (69327-76-0)	200	100	2	60	100	60	0.10	US EPA, 2022a
Captan[h] [as THPI equivalents] (133-06-2)	10	100	0.1	50	5.0	5.0	0.70	US EPA, 2018b
Carbaryl (63-25-2)	1	100	0.01	21	0.50	0.50	0.50	DPR, 2014
Carbendazim** (10605-21-7)	10	100	0.1	NA	5.0	5.0	2.0	US EPA, 2020n
Carbofuran* (1563-66-2)	0.01	100	0.0001	0.2	0.0050	0.0050	0.50	DPR, 2006
Chlorantraniliprole (500008-45-7)	158	100	1.58	40	79	40	14	US EPA, 2020c

Table B. Detailed list of revised pesticide action levels for legally grown cannabis in California

Pesticides (CAS RN)	**POD**[a] (mg/kg/day)	**UF_{TOTAL}**[b]	**RfD**[c] (mg/kg/day)	**Tolerance**[d] (ppm)	**Risk-based Action Level**[e] (ppm)	**Proposed Action Level for Other Goods**[f] (ppm)	**Proposed Action Level for Inhalable Goods**[g] (ppm)	**RfD Reference**
Chlordane*[i] (cis-chlordane 5103-71-9, trans-chlordane 5103-74-2)	0.1	100	0.001	0.1	0.050	0.050	0.10	ATSDR, 2018
Chlorfenapyr* (122453-73-0)	5	100	0.05	80	2.5	2.5	0.10	US EPA, 2020d
Chlorpyrifos* (2921-88-2)	0.01	100	0.0001	15	0.0050	0.0050	0.50	DPR, 2018
Clofentezine (74115-24-5)	1.25	100	0.013	3	0.65	0.65	0.10	US EPA, 2019a
Coumaphos* (56-72-4)	0.19	1000	0.00019	0.15	0.010	0.010	0.10	US EPA, 2016a
Cyfluthrin (68359-37-5)	1.17	100	0.0117	7	0.59	0.59	2.0	US EPA, 2019b
Cypermethrin (52315-07-8)	1.4	100	0.014	14	0.70	0.70	1.0	US EPA, 2020e
Cyprodinil** (121552-61-2)	200	100	2	50	100	50	0.10	US EPA, 2023c
Dacthal (DCPA) (1861-32-1)	0.1	100	0.001	5	0.05	0.050	0.10	USEPA, 2023d
Daminozide* (1596-84-5)	390	100	3.9	0.1	195	0.10	0.10	US EPA, 2014b; EU, 2014
Diazinon (333-41-5)	3	1000	0.003	0.7	0.15	0.15	0.10	US EPA, 2016b
DDVP (Dichlorvos)* (62-73-7)	0.83	1000	0.00083	0.5	0.042	0.042	0.10	US EPA, 2020f
Dimethoate* (60-51-5)	2.4	100	0.24	2	12	2.0	0.10	US EPA, 2023e
Dimethomorph (110488-70-5)	25	100	0.25	30	13	13	2.0	US EPA, 2015a
Ethoprop(hos)* (13194-48-4)	0.42	1000	0.0004	0.02	0.021	0.020	0.10	US EPA, 2015b

Table B. Detailed list of revised pesticide action levels for legally grown cannabis in California

Pesticides (CAS RN)	**POD**[a] (mg/kg/day)	**UF_{TOTAL}**[b]	**RfD**[c] (mg/kg/day)	**Tolerance**[d] (ppm)	**Risk-based Action Level**[e] (ppm)	**Proposed Action Level for Other Goods**[f] (ppm)	**Proposed Action Level for Inhalable Goods**[g] (ppm)	**RfD Reference**
Etofenprox* (80844-07-1)	25.5	100	0.255	5	13	5.0	0.1	US EPA, 2022b
Etoxazole (153233-91-1)	4.62	100	0.046	1.5	2.3	1.5	0.10	US EPA, 2019c
Fenhexamid (126833-17-8)	38	100	0.38	30	19	19	0.10	US EPA, 2019d
Fenoxycarb* (72490-01-8)	200	100	2	3	100	3.0	0.10	EFSA, 2010; EFSA, 2018
Fenpyroximate (111812-58-9)	37.5	100	0.375	4	18.75	4.0	0.10	US EPA, 2020g
Fipronil* (120068-37-3)	0.77	100	0.008	0.03	0.4	0.030	0.10	DPR, 2023
Flonicamid (158062-67-0)	12	100	0.12	16	6.0	6.0	0.10	US EPA, 2024a
Fludioxonil (131341-86-1)	50	100	0.5	30	25	25	0.10	US EPA, 2023f
Fluopyram** (658066-35-4)	50	100	0.5	50	25	25	5.0	US EPA 2023g
Hexythiazox (78587-05-0)	30	100	0.3	6	15	6.0	0.10	US EPA, 2020h
Imazalil* (35554-44-0)	10	100	0.1	10	5.0	5.0	0.10	US EPA, 2018c
Imidacloprid (138261-41-3)	5.5	100	0.06	4	3.0	3.0	5.0	DPR, 2024
Kresoxim-methyl (143390-89-0)	108.7	100	1.09	1	54.5	1.0	0.10	US EPA, 2016c
Malathion (121-75-5)	24.3	10	2.43	8	121.5	8.0	0.50	US EPA, 2024b
Metalaxyl (57837-19-1)	50	100	0.5	15	25	15	2.0	US EPA, 2020i
Methamidophos** (10265-92-6)	0.0986	100	0.000986	NA	0.049	0.049	1.0	US EPA 2023a

Table B. Detailed list of revised pesticide action levels for legally grown cannabis in California

Pesticides (CAS RN)	**POD**[a] (mg/kg/day)	**UF_{TOTAL}**[b]	**RfD**[c] (mg/kg/day)	**Tolerance**[d] (ppm)	**Risk-based Action Level**[e] (ppm)	**Proposed Action Level for Other Goods**[f] (ppm)	**Proposed Action Level for Inhalable Goods**[g] (ppm)	**RfD Reference**
Methiocarb* (2032-65-7)	0.03	100	0.0003	NA	0.015	0.015	0.20	US EPA, 2017a
Methomyl (16752-77-5)	0.03	20	0.0015	6	0.075	0.075	1.0	US EPA, 2018d
Methyl parathion* (298-00-0)	0.025	1000	0.000025	NA	0.0013	0.0013	0.10	DPR, 2010; US EPA, 2015c
Mevinphos* (7786-34-7)	0.1	300	0.0003	NA	0.017	0.017	0.040	US EPA, 2000
Monocrotophos** (6923-22-4)	0.0059	100	0.00006	NA	0.0030	0.0030	0.30	FAO/UNEP, 2005
Myclobutanil (88671-89-0)	60	100	0.6	9	30	9.0	0.10	US EPA, 2021d
Naled (300-76-5)	3.2	1000	0.003	3	0.16	0.16	0.10	US EPA, 2020j
Omethoate** (1113-02-6)	0.36	10	0.036	2	1.8	1.8	0.10	US EPA, 2023e
Oxamyl (23135-22-0)	0.069	26	0.0026	10	0.13	0.13	0.50	US EPA, 2017b
Paclobutrazol* (76738-62-0)	10	100	0.1	NA	5.0	5.0	0.10	US EPA 2015d
Pentachloronitrobenzene (82-68-8)	36	300	0.12	1	6.0	1.0	0.10	US EPA, 2021e
Permethrin (52645-53-1)	44	100	0.44	20	22	20	0.50	US EPA, 2020k
Phosmet (732-11-6)	1.4	1000	0.0014	25	0.070	0.070	0.10	US EPA, 2016d
Piperonyl butoxide (51-03-6)	500	100	5	8	250	8.0	3.0	US EPA, 2017c
Prallethrin (23031-36-9)	2.5	100	0.025	1	1.25	1.0	0.10	US EPA, 2020l
Propiconazole (60207-90-1)	100	100	1	20	50	20	0.10	US EPA, 2022c

Table B. Detailed list of revised pesticide action levels for legally grown cannabis in California

Pesticides (CAS RN)	**POD**[a] (mg/kg/day)	**UF_{TOTAL}**[b]	**RfD**[c] (mg/kg/day)	**Tolerance**[d] (ppm)	**Risk-based Action Level**[e] (ppm)	**Proposed Action Level for Other Goods**[f] (ppm)	**Proposed Action Level for Inhalable Goods**[g] (ppm)	**RfD Reference**
Propoxur* (114-26-1)	0.038	100	0.00038	NA	0.019	0.019	0.10	US EPA, 2015e
Pymetrozine** (123312-89-0)	0.81	100	0.008	0.6	0.40	0.40	1.0	US EPA, 2018e
Pyraclostrobin** (175013-18-0)	5	100	0.05	40	2.5	2.5	0.10	US EPA, 2021f
Pyrethrins[j] (8003-34-7)	20	100	0.2	1	10	1.0	0.50	US EPA, 2017d; US EPA, 2019e
Pyridaben (96489-71-3)	44	100	0.44	3	22	3.0	0.10	US EPA, 2020m
Pyrimethanil** (53112-28-0)	100	100	1	15	50	15	0.10	US EPA, 2024c
Spinetoram (935545-74-7)	4.9	100	0.049	8	2.5	2.5	0.10	US EPA, 2023h
Spinosad[k] (131929-60-7, 168316-95-8)	4.9	100	0.049	10	2.5	2.5	0.10	US EPA, 2023h
Spiromesifen (283594-90-1)	3.8	100	0.038	12	1.9	1.9	0.10	US EPA, 2024d
Spirotetramat (203313-25-1)	100	100	1	13	50	13	0.10	US EPA, 2017e
Spiroxamine* (118134-30-8)	10	100	0.1	0.7	5	0.70	0.10	US EPA, 2010
Tebuconazole (107534-96-3)	3	100	0.03	9	1.5	1.5	18	US EPA, 2021g
Thiacloprid* (111988-49-9)	4.4	100	0.044	1	2.2	1.0	0.10	US EPA, 2012
Thiamethoxam (153719-23-4)	34.5	100	0.35	4.5	17.5	4.5	5.0	US EPA, 2022d
Trifloxystrobin (141517-21-7)	250	100	2.5	30	125	30	0.10	US EPA, 2023i

*Indicates former Category I pesticide; **Indicates new pesticides proposed for mandatory testing.

[a]POD – Point of departure; In toxicology, the POD is related to the dose at which a biological response is first observed and is a basis for making extrapolations needed for assessing risks. This toxicity threshold is the dose/concentration of a substance below which adverse effects are not seen. Generally based on observational data from animal experiments corresponding to an estimated low effect level or no effect level. It marks the beginning of extrapolation to toxicological reference dose (RfD) or reference concentration (RfC).

[b]UF_{TOTAL} – Total uncertainty factors. Uncertainty factors account for uncertainty in experimental, observed, or derived data and are often applied to points of departure (POD) in the calculation of reference doses (RfDs) or reference concentrations (RfCs). When deriving RfDs/RfCs from experimental data, the total uncertainty factor (Total UF or UF_T) is generally comprised of a factor of 10x to account for interspecies extrapolation sensitivity (UF_A) and a factor of 10x to account for intraspecies (human) variability (UF_H).

[c]RfD – Reference Dose. As defined by US EPA, an acute RfD is an estimate of a daily oral chemical (such as pesticide) exposure for an acute duration (24 hours of less) to the human population including sensitive subgroups that is likely to be without appreciable risk of deleterious effects during a lifetime (US EPA, Integrated Risk Information System (IRIS) Glossary. https://www.epa.gov/iris/iris-glossary). These values are calculated by dividing the critical endpoint values (points of departure, PODs) by the total uncertainty factor (UF_{TOTAL}).

[d]Tolerance – The US Environmental Protection Agency (US EPA) sets tolerances, which are the maximum amount of a pesticide allowed to remain in or on food, as part of the process of regulating pesticides. By law, US EPA is responsible for regulating the pesticides that are used by growers to protect crops grown for human food and animal feed and for setting limits on the concentration of pesticides that may remain in or on foods sold in the US. US EPA establishes there values for specific crops based on a risk assessment that considers aggregate exposure from the pesticide through diet and drinking water and from pesticides used in and around the home, the cumulative effects from exposure to pesticides that have a common mechanism of toxicity (that is, two or more pesticide chemicals or other substances that cause a common toxic effect(s) by the same, or essentially the same, sequence of major biochemical events, interpreted as mode of action), whether there is increased susceptibility to infants and children or other sensitive subpopulations, and whether the pesticide is considered an endocrine disrupter. Specific tolerances for each pesticide and crop treated can be found in the Code of Federal Regulations, CFR Title 40, Part 180. Tolerances and Exemptions for Pesticide Chemical Residues in Food. https://ecfr.io/Title-40/pt40.26.180. Carbendazim and propoxur have no registered food uses, therefore tolerance is not applicable (N/A). Methamidophos, methyl parathion, mevinphos, and monocrotophos have all been cancelled. There is no legal use in the US and tolerances have been revoked (also marked NA). Because the calculated action levels for daminozide and fenoxycarb were ≥ 100 ppm, European Union (EU) maximum residue levels (MRLs) were used as these two pesticides have no registered food uses in the US (and therefore no US EPA tolerance) and to provide a more health-protective approach.

[e]Risk Based Action Level – Risk based action levels are based on reference doses derived from mammalian toxicity tests and estimated human consumption. Because only preliminary data are available at this time to determine human consumption of different types of cannabis products, DPR developed a surrogate method using agricultural commodities with known consumption data. This approached is based on the same methodology used by DPR's California Pesticide Residue Monitoring Program (CPRMP) to determine whether potential health risks exist from exposure to illegal pesticide residues on raw produce. Risk based action levels for edible cannabis products (ug pesticide/g cannabis) are calculated by dividing the RfD (mg pesticide/kg body weight-day) by the surrogate cannabis consumption rate (g/kg body weight-day). Where possible, values are given as two significant figures.

[f]Proposed Action Level for Other Cannabis Goods – At this time, the proposed action levels for other cannabis goods are based on reference doses and surrogate data for consumption of edible cannabis products. The proposed action level will be one of two options: 1) the risk based action level as

described above if lower than the corresponding US EPA tolerance for the pesticide in fresh agricultural commodities, or 2) the US EPA tolerance if it is lower than the risk based action level. In two instances (daminozide and fenoxycarb), EU MRLs are substituted for US EPA tolerances as noted above.

[g]Proposed Action Level for Inhalable Goods (ppm) – Values have been revised based on any updated Guidance Residue Levels (GRL) available for pesticides on tobacco established by CORESTA, an international cooperative research center for tobacco headquartered in France (CORESTA, 2016). DPR used the CORESTA GRLs as the action levels for dried cannabis flowers as these levels reflect the highest acceptable residues resulting from good agricultural practices, detection limits, and physical and chemical properties. If a GRL has not been established for a pesticide, then the US EPA regulatory level of 0.1 µg/g (0.1 parts per million, ppm) was used as a surrogate action level for inhalable cannabis products. This is the pesticide residue level for tobacco that triggers the US EPA to require pyrolysis testing (US EPA, 1996).

[h]Captan metabolizes and degrades in the environment rapidly into tetrahydrophthalimide (THPI), which is detected on crops. US EPA considers THPI have equivalent toxicity to the parent captan and US EPA includes THPI in the residue tolerances established for captan. Cannabis products should be tested for both captan and THPI. If detected, THPI should be converted to captan equivalent and added to the parent to calculate a total captain residue.

[i]Chlordane exists as an isomeric mixture in combination with many related chemicals. Sixty to 85% of technical chlordane consists of the stereoisomers cis- and trans-chlordane, the ratio of which depends on the manufacturing process (ATSDR, 2018).

[j]Pyrethrins refer to the insecticidal active ingredients present in pyrethrum extracts obtained from the flowers of the pyrethrum plant, Chrysanthemum cinerariaefolium. Individual pyrethrins in the mixture include pyrethrin I and II, cinerin I and II and jasmolin I and II. The action levels are based on toxicity of the mixture (CAS RN 8003-34-7) and residue testing should be based on measurements of pyrethrin I and II.

[k]Spinosad exists as a two-component mixture comprised of spinosyn A (CAS RN 131929-60-7) and spinosyn D (CAS RN 131929-63-0) in a ratio of approximately 5:1. Obtained from the fermentation of the naturally occurring soil dwelling bacterium Saccharopolyspora spinosa, it is used for the topical treatment of head lice. https://pubchem.ncbi.nlm.nih.gov/#query=Spinosad

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