UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
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OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

MEMORANDUM

SUBJECT: Benefits Information and Response to Comments for Registration Review Proposed Interim Decision (PID): Buprofezin (PC Code: 275100)

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SUMMARY

Buprofezin is undergoing the registration review process. Buprofezin is a chitin biosynthesis inhibitor, registered for use as an insect growth regulator (IGR), and used to control primarily hemipteran pests on a variety of crops.

Buprofezin offers high benefits to certain crops such as cotton, grapes, pears, and pistachios for control of key pests within those production systems. Buprofezin is a key control option and

rotational partner for growers managing resistant pests such as sweet potato whiteflies in cotton and pear psylla in pears. In grapes, buprofezin is typically used to target mealybugs. All species of mealybugs can transmit grape viruses such as leafroll and corky bark, which can result in vine dieback and yield loss. Additionally, buprofezin is the top control option for Gill's mealybugs in pistachios. This pest can directly damage pistachios by reducing nut size, and potentially cracking the hull of the nut leading to dried nuts. Banana, citrus, coffee, pomegranate and olive growers use buprofezin to manage scales and psyllids, which are key pests in these systems.

The Office of Pesticide Programs (OPP) is considering various mitigation options to reduce risks to human health and the environment. To address bystander risks, OPP is considering drift reduction measures and/or buffer zones for aerial applications to orchards and vineyards. Aerial applications of buprofezin to orchards and vineyards are not common, so low impacts to users are expected. Nevertheless, there does appear to be sporadic use of aerial applications in apples in certain locales (*i.e.,* Pennsylvania), so for these acres, the impacts may be higher. These buprofezin users may need to switch to alternative methods of application, e.g. ground, or use alternative pesticides if aerial restrictions make use of buprofezin too onerous.

To address occupational handler (e.g. mixers, loaders, and applicators) risks, certain types of applications (e.g. aerial, fogging and mechanically pressurized hand-gun) may be limited or prohibited. Water soluble packets (WSP) formulations are currently not commercialized (per the registrant), so the prohibition of aerial applications of this formulation to orchards/vineyards is expected to have no impacts on users. Fogging is not a recommended application method for orchard, vineyards or field production scenarios, as it works most favorably when performed in enclosed spaces. Therefore, the limitations and prohibitions on fogging applications are not expected to be impactful on users, unless its use is restricted in greenhouses. The use of mechanically pressurized handguns (MPHs) is common for spot or perimeter treatments, but they are generally regarded as not suitable for general field use due to efficiency issues such as time and labor costs and issues with ensuring complete coverage relative to other types of application equipment (i.e., boom sprayer or airblast sprayer). The Agency has data on the extent of spot treatments on many agricultural crops, but there have not been any buprofezin spot treatments in recent years. Therefore, the Agency expects low impacts on users from the prohibition of buprofezin applications by MPHs of certain formulations in orchards, vineyards and typical field crops. BEAD does not have data on backpack applications of buprofezin, so the impacts on users of limitations or prohibition of this method is uncertain.

OPP is also proposing requiring additional personal protective equipment (PPE) for several other uses and application methods to reduce dermal and inhalation exposure to occupational handlers while mixing, loading, and/or applying buprofezin. The addition of a requirement to be in an enclosed cab for airblast applications and increases in PPE proposed (e.g. double layers (coveralls), gloves, chemical hat, and respirators) for several application scenarios are expected to have low impacts on users, with one exception. The addition of respirators for fogging applications of soluble concentrates will impact users. If a buprofezin handler currently does not have a respirator, an additional cost will be incurred by the handler or the handler's employer, which includes the cost of the respirator plus, for Worker Protection Standard covered products, the cost for a respirator fit test, training, and medical exam.

To address post application risks to workers, OPP may reduce application rates and increase the restricted entry intervals (REIs), currently 12 hours, for pome and stone fruit, grapes, olives, nursery ornamentals, pears and Asian pears to 1 – 8 days (depending on the crop). The impacts on users of reducing the pear application rate to 1.6 pounds of active ingredient per acre (lbs ai/acre) and the grape application rate to 0.6 lbs ai/acre are expected to be minimal. The post application activities of most crops are not expected to be heavily impacted by the increase in REIs, except for grapes (6 days for 1.05 lb ai/acre). Some impacts for post application activities may arise from posting requirements for REI's of 48 hours or more. The requirement to post and remove signage around the perimeter of the treated field will result in direct increases in time and labor costs and will likely decrease the ease of use that buprofezin currently offers to growers.

The spray drift reduction measures such as droplet size restrictions and other mitigations such as reductions in the application rates being proposed would also decrease ecological risks from buprofezin. BEAD does not know how efficacy may be impacted when droplet size increases are required for various insecticides. This is a concern where there is a dense canopy (e.g., cotton) and finer droplets are required to penetrate the canopy where the target pests reside (e.g., whiteflies). The dependency of one route of exposure vs. another is variable by target pest and in some cases the target stage of development of that pest. These restrictions may also impact pre-mix or tank mix partners with less systemic chemical profiles or chemical adjuvants which may be rendered ineffective when applied at a larger droplet size.

INTRODUCTION

Section 3(g) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) mandates that the United States Environmental Protection Agency (EPA) periodically review the registrations of all pesticides to ensure that they do not pose unreasonable adverse effects to human health and the environment. This periodic review is necessary in light of scientific advancements, changes in policy, and changes in use patterns that may alter the conditions underpinning previous registration decisions. In determining whether effects are unreasonable, FIFRA requires that the Agency consider the risks and benefits of any use of the pesticide.

Buprofezin is an insect growth regulator and is classified as a Group 16 chemical (chitin biosynthesis inhibitor) by IRAC (2011), first registered by the EPA in 2000. Buprofezin is available in multiple products formulated as a wettable powder, soluble concentrate, water dispersible granule, and emulsifiable concentrate. These products control heteropteran pests such as whiteflies, mealy bugs, leafhoppers, plant hoppers, and scales in a variety of crops. Buprofezin is applied as a foliar application using the following methods: broadcast applications using ground and aerial equipment or as a high volume dilute/low volume concentrate/ultra-low volume spray using foggers, ground and airblast sprayers. Buprofezin is registered for use on cotton and ornamentals plants as well as a variety of food/feed crops including pistachios, grapes, berries, stone fruit, pome fruit, tropical fruits, citrus, vegetables and coffee.

EPA has completed human health and ecological risk assessments for buprofezin and identified several risks of concern:

- Risks to bystanders, especially children (one to two years old), in areas adjacent to orchards and vineyards if treated by air;
- Risks to handlers in certain scenarios even with maximum PPE or engineering controls (EC):
    - Mixing/loading dry flowables for aerial applications to orchards/vineyards;
    - Mixing/loading water soluble packets for aerial applications to orchards/vineyards;
    - Mixing/loading/applying soluble concentrates and water-soluble packets for mechanically pressurized handgun to treat orchards/vineyards, and typical field crops;
    - Mixing/loading/applying dry flowables for mechanically pressurized handgun applications to orchards/vineyards, Christmas Tree farms, greenhouse ornamentals/vegetables, nursery ornamentals, and landscaping trees/shrubs/bushes;
- Risks to handlers that require increases in the current baseline PPE:
    - Mixing/loading/applying dry flowables or soluble concentrates for fogging orchards and vineyards;
    - Mixing/loading/applying dry flowables via backpack to Christmas Tree farms, nursery ornamentals, landscaping trees/shrubs/bushes/plants/flowers;
    - Applicator spray (all starting formulations) via airblast to orchards/vineyards;
    - Mixers/loaders for soluble concentrates for aerial application to orchards/vineyards;
- Risks to workers from post-application exposure that require an increase in the current restricted entry interval (REIs) of 12 hours:
    - Nursery ornamentals, Grapes (all @ 0.53 lb a.i./A) – 1 day
    - Pome fruit, Grapes (all @ 1.05 lb a.i./A) – 6 days
    - Pears (higher rate than other pomes), Asian Pears, and Olives – 8 days
- Risks to non-target organisms (*i.e.*, fish, invertebrates, birds and mammals)

OPP is considering various mitigation options to reduce risks to human health and the environment. These options and their impacts are discussed in impacts and conclusion sections of this document.

In this memo, BEAD summarizes buprofezin usage information, addresses certain public comments on the risk assessments, presents the benefits of buprofezin in agricultural production, primarily focusing on orchard and vineyard crops, and provides a discussion of the impacts of the proposed mitigation measures.

METHODOLOGY

The benefits of buprofezin use are evaluated based on its usefulness in crop production practices and systems. BEAD first identifies the primary pests targeted by growers when using buprofezin. Data for this purpose comes from university extension, peer-reviewed journal articles and pesticide market research data (MRD), collected through annual surveys of growers conducted by a leading private research firm. Survey information is collected following a statistically valid

approach. Site specific use and usage information was identified using the same survey data as well as state university extension recommendations. The most likely impacts resulting from proposed mitigations on growers using buprofezin are identified using best professional judgement based on biological considerations and economic theory.

The memorandum will be outlined as follows: usage information from MRD regarding buprofezin, a summary of the comments received regarding usage/benefits during the draft risk assessment phase, a description of the benefits of buprofezin use in sites with identified risks of concern, and a discussion of impacts expected to result from the proposed mitigation being assessed.

BUPROFEZIN CHEMICAL CHARACTERISTICS

Buprofezin is an insect growth regulator (IGR) and is classified as a Group 16 chemical (chitin biosynthesis inhibitor) by IRAC (2018). It is the only pesticide in this group so it is a unique MOA. Buprofezin is available in multiple products. Buprofezin controls hemipteran pests such as whiteflies, mealy bugs, leafhoppers, plant hoppers, and scales and is widely registered across many agricultural crops (Cornell, 2003). Buprofezin is available in four formulations as an emulsifiable concentrate, a soluble concentrate, a wettable powder and as water dispersible granules.

The initial use of insect growth regulators, such as buprofezin, in the mid-1990's allowed for successful resistance management programs in crops where insecticide resistance (*e.g.*, organophosphates (OPs), carbamates and pyrethroids) had become a problem (*e.g.*, whiteflies in cotton) (Kaul et al. 2011). Recently, the Q biotype whitefly (*Bemisia tabaci*), found in 25 states and mostly isolated to nurseries, has shown resistance to acetamiprid, buprofezin, imidacloprid, pyriproxyfen, and thiamethoxam as well as other insecticides (Dennehy et al., 2008; Leibee et al., 2011). Resistance has been an ongoing problem with whiteflies, and resistance management programs are needed for successful whitefly management (Dennehy et al., 2008; Leibee et al., 2011).

BUPROFEZIN USAGE

There are approximately 176,000 pounds of buprofezin applied to 219,000 acres annually (Market Research Data [MRD] 2012-2016). Table 1 presents buprofezin usage information on all crops with a percent crop treated (PCT) greater than 5% and/or crops with risks of concern (ROCs) from buprofezin use. Low PCT (less than 5%) is often an indication that growers have efficacious alternatives and/or that the pests being targeted are less important or sporadic, so less focus will be on these crops for buprofezin, unless there are related risk concerns (i.e. apples and cotton), since these crops or use sites are less likely to have high benefits from buprofezin use.

Lettuce and pistachios have the highest number of acres treated (TAT) with buprofezin as shown in Table 1. Pistachios, pears, and cherries have high usage of buprofezin in terms of pounds applied. Strawberries, pears, and pistachios have the highest PCT. Most crops have average

single application rates below 1 pound of active ingredient per acre (lb ai/acre) with the exception of some fruit and nut tree crops. The maximum number of applications for most crops does not exceed two. The average number of applications for most crops is around one per year, with strawberries having the highest average number of applications (MRD 2012-2016).

Table 1. Average Buprofezin Usage Data for Select Crops*

Crop	Total Area Treated (TAT)	Pounds Applied (lbs)	Single Application Rate (lbs ai/acre)	Number of Times Applied	Percent Crop Treated (PCT)
Apples	5,700	5,000	0.86	1.42	1%
Cantaloupes	7,900	2,100	0.27	1.15	12%
Cauliflower	3,800	1,000	0.27	1.30	8%
Cherries	8,100	12,200	1.51	1.00	6%
Cotton	15,700	4,800	0.31	1.07	<1%
Grapes, Table	6,300	3,000	0.48	1.06	5%
Lettuce	39,300	9,600	0.24	1.30	11%
Pears	8,100	12,300	1.51	1.16	13%
Pistachios	44,000	67,800	1.54	1.00	17%
Strawberries	10,800	3,500	0.33	1.53	13%

Source: MRD 2012-2016

* These crops were selected because they have a percent crop treated (PCT) greater than 5% and/or risks of concern (ROCs) from buprofezin use. Crops that are not listed, but for which BEAD has recent data include: Grapes (raisin), Grapefruit, Peaches, Apricots, Broccoli, Cabbage, Squash, Walnuts, Grapes (wine), Watermelons, Plums/Prunes, Oranges, Lemons, Cucumbers, Peppers, Almonds, Tomatoes, Celery, Pumpkins, and Spinach.

RESPONSE TO COMMENTS

The Agency received comments from the Almond Alliance of California, California Fresh Fruit Association, IR-4 Program, National Agricultural Aviation Association (NAAA), National Cotton Council, Northwest Horticultural Council (NHC), United States Department of Agriculture Office of Pest Management Policy (USDA OPMP) and University of Hawaii. BEAD appreciates the information provided therein regarding the benefits of buprofezin and thanks the commenters for the additional input.

The discussion within these comments centered around the following general themes: the usefulness of buprofezin as a high efficacy tool, buprofezin's capacity to control key pests including vectors of pathogens in various production systems, its benefit as a resistance management partner, and its selectivity against predatory or parasitoid insects. BEAD cited information provided by some commenters, when information was relevant to the uses and proposed mitigations being assessed throughout in this document (i.e., USDA OPMP, NHC, NAAA and the University of Hawaii).

EVALUATION OF THE BENEFITS OF BUPROFEZIN

Qualitative Benefits

Below, BEAD qualitatively considers the role of buprofezin in the agricultural insecticide programs for both orchard and vineyard crops, which are sites with high usage or risks of concern from buprofezin use. Many of these sites are listed in Table 1 in the Usage section of this memo.

Pear

In pears, buprofezin is mainly used to target the pear psylla (*Cacopsylla pyrcola*), based on acres treated (MRD, 2012-2016). Pear psylla is a historically invasive pest that has become one of the primary and most damaging pests of pear production in the United States (Murray and DeFrancesco, 2014), particularly due to its propensity for development of resistance (UC-IPM, 2012a). Pear psylla over-winter as adults and emerge to lay eggs on dormant pear trees in the early spring prior to bud emergence through bud swell and early bud emergence or 'white bud' stages (PSU, undated). As nymphs hatch, they feed on buds and emerging leaves through pear bloom and into petal fall. Subsequent generations attack leaves and shoots for the entire growing season, for four or more successive generations (PSU, undated; UC-IPM, 2012a). Feeding by both adults and nymphs results in secretion of large amounts of honeydew that can coat foliage and fruit, resulting in growth of sooty mold. Such damage can cause a severe quality impact on pears, and at heavier infestation levels, trees can become defoliated and stunted (UC-IPM, 2012a). Because of the long seasonal susceptibility to this pest and the pest's historical propensity for resistance development, control of pear psylla requires a season-long management program that includes rotation of multiple insecticide modes of action. This generally includes aggressive control tactics aimed at early season population knockdown using at least 2-3 insecticide sprays prior to bloom, in the hopes of reducing the population to a low and more manageable level for the remainder of the season (WSU, 2009).

Therefore, failure to control pear psylla in this early-season window will result in more difficult and expensive management efforts for the remainder of the growing season. Pear psylla damage has a positive correlation with high tree vigor, as vigorous trees producing copious amounts of succulent new growth are providing the most favorable habitat for this pest to feed resulting in the most damage. While vigor can be managed somewhat by use of plant growth regulators, the difficulty of pear psylla control can vary by variety, even with vigor control. Chemical intervention is typically necessary to maintain protection from this pest (Murray and DeFrancesco, 2014).

Buprofezin is the top recommended insecticide by UC IPM as a petal fall material to target pear psylla egg hatchlings, followed by spirotetramat and abamectin (UC-IPM, 2012a).

Grapes

Mealybug species, in the genus's *Pseudococcus* and *Planococcus*, are the most frequent targets of buprofezin applications in grapes (MRD 2012-2016). Susceptibility to mealybugs is variable by grape variety (UC IPM 2015a; UC IPM 2015b). Mealybug infested grape clusters become contaminated with cottony egg sacs, insects, and honeydew that can lead to sooty mold (UC IPM 2015a, b). Severe infestations may lead to grapevine defoliation or spur and cane death (Daane et al. 2004). Furthermore, severely infested fruit may not be capable of harvest if honeydew and

mold levels are high (Daane et al. 2004). All species of mealybugs can transmit grape viruses such as leafroll and corky bark (UC IPM 2015a; UC IPM 2015b). Buprofezin is the only active ingredient recommended to manage early spring mealybug nymphs according to UC extension (UC IPM 2015a; UC IPM 2015b). Recommendations for late spring applications list buprofezin, spirotetramat and the neonicotinoids (clothianidin, dinotefuran, imidacloprid, and thiamethoxam) (UC IPM 2015b).

Olives

California accounts for over 95% of olives are grown in the U.S. (USDA NASS 2011-2015). Currently available data on U.S. olive production is limited, specifically data on the pests growers target is not available. Based on the publicly available usage data sourced from USDA and California, roughly 16% of olive acres grown are treated regularly with insecticides (USDA NASS, various years). Since there were about 38,800 acres of olives grown in California from 2011 to 2015, and there were about 500 olive acres treated with buprofezin over that same period, BEAD estimates that the PCT for olives is about 1% (USDA NASS 2011-2015, CDPR 2011-2015). Several species of scale such as black scale (*Saissetia olieae*) as well as olive psyllid (*Euphyllura olivine*) are the identified pests that may be targeted using buprofezin in olive production (UC IPM, 2014a). Pests such as olive psyllid and black scale can produce honeydew and large infestation lead to the development of sooty mold which may reduce the quality of the crop and result in serious crop losses (UC IPM, 2014a; COC, 2004). According to the UC IPM (2014a), high psyllid infestations commonly cause desiccation of developing buds, flowers, fruits, and shoots and induce fruit drop in olive production equating to a 30 to 60% yield loss (UC IPM, 2014a).

The Agency received comment from the University of Hawaii Manoa stating the importance of buprofezin in the production of various tropical fruits such as banana, citrus, coffee, pomegranate as well as olives. They stated that because buprofezin has a 12-hour REI, worker activities such as weed management and other cultural practices can occur as needed. They also stated that buprofezin may reduce the use of multiple insecticides by controlling several of the most common pests across these production systems, a spectrum of heteropteran pests that would otherwise require multiple insecticides to control (EPA-HQ-OPP-2012-0373).

Tree Nuts

Buprofezin targets Gill's mealybugs (*Ferrisia gilli*) in addition to several scale species in pistachios where it is the preferred active ingredient by far followed by spirotetramat, imidacloprid, and acetamiprid (UC IPM, 2014b). Buprofezin has high efficacy when used on the first generation of the season of juvenile mealybugs around June (UC IPM, 2014b). Gill's mealybugs produce honeydew that can become sooty mold when feeding on pistachios. Gill's mealybugs directly damage pistachios by reducing nut size and potentially cracking the hull of the nut leading to dried nuts. Furthermore, dried hulls can serve as overwintering sites for other pests including navel orangeworm (*Amyelois transitella*), another pest of pistachio. Buprofezin is the top recommended pesticide for early season mealybug control in pistachios by University of California Extension (UC IPM, 2014b).

According to USDA Office of Pest Management and Policy, buprofezin's benefit to growers for controlling certain scale insect pests has been increasing in tree-fruit and nut crops over the past

15 years, as many IPM programs in these crops have shifted away from broad-spectrum organophosphate and carbamate insecticides that provided collateral control of scale to more selective insecticides that do not provide control of scale (EPA-HQ-OPP-2012-0373-0034).

IMPACTS OF PROPOSED MITIGATION FOR BUPROFEZIN

OPP has completed human health and ecological risk assessments for buprofezin and identified several risks of concern. This section will discuss the impacts of the mitigation options being considered to address the aforementioned risks.

Cancellation of Aerial Applications in Orchards/Vineyards

There are bystander (i.e. non-occupational spray drift) risks and risks to occupational handlers from aerial treatments of buprofezin to orchards and vineyards. The Agency is proposing to prohibit aerial applications to these crops. Only 13% of all acres treated with buprofezin are treated aerially (MRD 2012-2016). Generally, aerial applications of buprofezin to orchards and vineyards are not common. While there are eight crops that have recently reported aerial use of buprofezin, apples are the only (orchard/vineyard) crop with usage and risks associated from this application method. Only about 1% of all apples are treated with buprofezin (via any application method), but of these treatments around 35% (2,000 acres) are aerial applications. (MRD 2012-2016)

Apples have a low PCT with buprofezin which is an indication that there are likely efficacious alternatives to buprofezin. Thus, prohibiting aerial applications to apples, i.e. the only orchard/vineyard crop with aerial usage and risks, is expected to have low impacts on apple growers. About two-thirds of buprofezin use in apples is in Pennsylvania and all of the reported aerial use of buprofezin in apples is in Pennsylvania. There may be a localized pest problem in Pennsylvania that buprofezin is effective in controlling. It may also be the case that aerial application provides benefits for growers under certain conditions (*e.g.*, in the case of water-logged fields due to rain) since they would likely use cheaper methods of application (e.g., ground) if it were feasible. According to NAAA, aerial application offers the only means of applying a crop protection product when the ground is wet and when time is crucial during a pest outbreak (EPA-HQ-OPP-2012-0373-0036). Given the limited data on aerial applications of buprofezin to apples, the impacts of this change may be subject to some uncertainty, as there may be similar issues or niche uses in other states. However, the data available to BEAD at this time does not support the assumption that there are similar issues or niche uses in other states.

Mealybugs and scales are typically the pests targeted in apples with this chemical (MRD 2012-2016). Comments on EPA's draft risk assessments (DRAs) for buprofezin from NHC, CFFA, and USDA also support that these are important pests in tree fruit production, including apples. NHC (a group representing PNW growers of apples, cherries, and pears) stated that buprofezin has "excellent efficacy against grape mealybug, which has been an increasingly severe pest in pear and apple orchards." USDA provided testimony from an entomologist in Michigan that buprofezin is a "critical tool in managing San Jose Scale (SJS) in MI tree fruit production." San

Jose Scale is typically a target pest of aerial and ground applications in Pennsylvania (MRD 2012-2016).

Aerial applications of buprofezin are not common to orchard and vineyard crops, so low impacts overall are expected from restrictions on this method or its prohibition. Nevertheless, there does appear to be sporadic use of aerial application on some apple acres in certain locales (*i.e.*, Pennsylvania), so for these acres, the impacts may be larger. These buprofezin users may need to switch to alternative methods of application, e.g. ground, or use alternative methods of control if aerial restrictions make use of buprofezin too onerous.

Cancellation of Fogging Equipment and Mechanically Pressurized Handgun

Buprofezin labels currently allow for fogging applications to be made to greenhouse tomatoes and ornamentals, and use of a mechanically pressurized handgun (MPH) for applications to all registered use sites. The human health risk assessment for buprofezin identified risks to all use sites for occupational handlers using MPHs to apply dry flowable or water dispersible granule formulations. Risks of concern were also identified for occupational handlers from fogging and mechanically pressurized handgun treatments to orchards, vineyards, and typical field crops from certain formulations (e.g. liquid, water dispersible granules, water-soluble packets, and wettable powder) when using these application methods. The Agency is proposing to cancel the use of MPHs and fogging equipment to apply buprofezin. Alternatively, the Agency may also choose to prohibit the use of certain formulations with these application methods.

BEAD has qualitative information, but no direct quantitative data on fogging applications of buprofezin. Fogging is typically used in greenhouse production scenarios, post-harvest applications, and outdoors for public health pests such as mosquitos (not a registered use of buprofezin). The emulsifiable concentrate (EPA Reg # 71711-21) and soluble concentrate (EPA Reg # 71711-20) formulations of buprofezin are good candidates for fogging in greenhouse production scenarios, as an IGR targeting pests such as mealybugs and whiteflies through contact and volatility exposures, for which good coverage is essential to achieve efficacious control. Fogging applications offer extremely fine droplets that ensure coverage for pests such as whitefly and mealybug when applied in enclosed spaces. Fogging is not a recommended application method for orchard, vineyards or field production scenarios, as the advantages of this ULV application method are most favorable when performed in enclosed spaces. Issues with drift and canopy penetration in the outdoor environment make fogging a prohibitive application method for orchards, vineyards and field crops alike. Low impacts are expected for growers from a fogging restriction or prohibition for buprofezin, with the possible exception of greenhouse uses.

BEAD has qualitative information, but no direct quantitative data on MPH applications of buprofezin. Mechanically pressurized handguns are commonly used for small scale production, research scale applications, perimeter applications and spot treatments. BEAD has data on spot treatments, but there have not been any buprofezin spot treatments reported in recent years (MRD 2012-2016). While the use of MPHs is common for spot or perimeter treatments, they are generally regarded as not suitable for general field use due to efficiency issues such as time and labor costs and issues with ensuring complete coverage relative to other types of application

equipment (*i.e.*, boom sprayer or airblast). Therefore, BEAD expects limited impacts on users from prohibiting applications of buprofezin by MPHs in orchards, vineyards and typical field crops.

Table 2 below shows the breakdown of buprofezin use for all crops treated by formulation type. Water dispersible granules is the primary formulation type (53% of all buprofezin acres treated) so prohibiting its use would likely have impacts for growers using these methods, while prohibiting the wettable powder formulation (3% of all buprofezin acres treated) would likely have lower impacts for growers. The registrant does not currently commercialize water-soluble packets, so the impacts to users of a prohibition of this formulation for buprofezin is expected to be minimal, since they are likely not using this formulation.

Table 2. Formulations of Buprofezin by Type and Area Treated

Formulation Type	**Total Area Treated (acres)**	**Percent of Total Area Treated (%)**
Dry Flowable/Water Dispersible Granules	116,000	53%
Liquid*	96,000	44%
Wettable Powder	7,000	3%
Total	**219,000**	**100%**

Source: MRD, 2012-2016.
*emulsifiable concentrates and soluble concentrates

Overall, the available usage data suggest that buprofezin spot and perimeter treatments do not occur, therefore the impacts of prohibiting or restricting use of MPHs are expected to be limited.

For non-greenhouse use sites, the impacts from a fogging restriction or prohibition are expected to be low. However, EPA does not know the importance of the fogging use of buprofezin in greenhouses, so the impacts of a fogging restriction or prohibition for this site is unknown. EPA encourages comments on the use of this method of application and the impacts to growers from prohibiting this application method.

Reduction in the Application Rate for Pears

To reduce post application risks to workers and ecological risks to various taxa, OPP is considering reducing the buprofezin application rate in pears (2.0 lbs ai/acre) to the rate for other related pome fruit like apples (1.5 lbs ai/acre). Data available to BEAD include detailed application rate information for pears as shown in Table 3. These data show that a reduction in the application rate to 1.5 lbs ai/acre would have a significant impact on many growers (nearly 85% of the pear acres treated with buprofezin are at 1.5 lbs ai/acre or higher). Based on the same data, a reduction to 1.6 lbs ai/acre would impact only 3% of acres treated with buprofezin by pear growers. (Table 3) It is not the case that these 3% of acres were systematically targeting a specific pest(s) in a given region which could indicate a niche pest (e.g., pear psylla) or issue that required a higher application rate.

Nevertheless, given the concern and history of pear psyllid resistance management and the losses seen when this pest is not properly controlled, the impacts of this mitigation may be somewhat uncertain.

Table 3. Distribution of (single) Application Rate and Annual Average Number of Applications of Buprofezin on Pears, 2012-2016

Average Application Rate (lb ai/A)	Rate Distribution	Average Number of Applications
1.51	16% of acres are treated at 1.50 lb ai/acre or less; 81% of acres treated at 1.51-1.60 lb ai/acre; 3% of acres treated at 1.7 lb ai/acre or more	1.16

Source: MRD, 2012-2016.

The impacts of reducing the pear application rate to 1.6 lbs ai/acre are not expected to be high, due to the limited percentage of affected acres. Although pear psylla is currently controlled at rates less than 1.6 lbs ai/acre, there may be some concerns over resistance evolving in the future.

Increase in Restricted Entry Intervals (REIs)

Pome and Stone Fruit

To reduce post application risks to workers, OPP is considering an increase in the Restricted Entry Interval (REI), currently 12 hours, to 6 days for pome and stone fruit for hand thinning fruit only. Given the higher application rate used on pears and Asian pears, the REI would be increased to 8 days for hand thinning of fruit.

For pome and stone fruit, there is an ideal window for hand thinning fruit, that lasts for a few weeks, so low impacts are expected from the change in REI to 6 days (or 8 days for pears) from 12 hours. When the timing of thinning fruit coincides with the need for insecticide applications, buprofezin may be one of the best control options that minimizes delays entering the field. However, the data available to BEAD does not show this overlap in applications (i.e. chemical thinning and insecticide treatments) to be the case for fruits like apples, pears, cherries, etc. (MRD 2012-2016). In addition, these crops are treated about once a year on average, so the impact of the increase in REI is not compounded due to multiple applications being needed (MRD 2012-2016).

Grapes

To reduce post application risks to workers, OPP is considering an increase of the REI for certain activities in grapes (tying/training vines and hand pulling leaves) based on the application rate. The current REI is 12 hours, which would be increased to 6 days for grapes (all) treated at 1.05 lbs ai/acre and 1 day for grapes (all grape types) treated at 0.53 lbs ai/acre.

For crops such as grape, to a lesser extent orchard crops (pome and stone fruit) and possibly olives, there are several cultural practices that need to take place in field (*i.e.*, leaf pulling, fruit thinning, training, propping, etc.). When the timing of these in-field activities, e.g. fruit thinning, coincides with the need for an insecticide application, buprofezin may offer the best control option that minimizes delays in subsequently entering the field given its current REI of 12 hours. Since buprofezin is an IGR and would be inefficacious if not applied at the proper timing relative to the target pest's life cycle stage, application would either take priority over whatever in-field activity needed to take place, or growers may need to switch to an alternative insecticide if they want to minimize delays in entering the field.

For some grapes (table and raisin), there is overlap between when a chemical thinning agent (*i.e.*, plant growth regulator (PGR)) might be applied and when buprofezin is used (MRD 2012-2016). If hand thinning after chemical thinning is a typical practice in grapes, then the growers, who use buprofezin at the higher rate of 1.05 lbs ai/acre, may be impacted by an increase in the REI. In addition, there are also key pests targeted by buprofezin in grapes (all), *e.g.*, mealybug, whose control could be impacted by an increase in the REI from 12 hours to 6 days. Wine grape acres are not treated with buprofezin (PCT 2%) to the same extent that as other types of grapes like table (PCT 5%) and raisin (PCT 4%) (MRD 2012-2016), so these growers may be less impacted by the increase in REI.

California and Arizona have higher maximum application rates than the rest of country, roughly double (1.05 lbs ai/acre versus 0.53 lbs ai/acre). However, data available to BEAD show that the reported rates used in grapes from various states, including California, are all less than 0.6 lbs ai/acre for all three types of grapes (MRD 2012-2016). The increase in REI (1 day) for this lower application rate (0.53 lbs ai/acre), is expected to have low impacts on growers.

Olives

To reduce post application risks to workers, EPA is considering an increase of the REI, currently 12 hours, to 8 days for olives for hand thinning.

It could be the case that buprofezin, with its unique mode of action (MOA), is used for niche/sporadic pests or as a rotational partner with carbaryl and spinosad, which are the other insecticides typically used in California olive production (CDPR 2011-2015). Without additional data on the pests being targeted, timing of applications, and the possible role buprofezin might play in olive integrated pest management (IPM), it is uncertain what the impacts of an increase of the REI from 12 hours to 8 days for hand thinning would be, such as impacts arising from delays in growers' ability to scout fields. However, if hand thinning is the preferred method over chemical thinning techniques, or if chemical thinning is commonly followed by hand thinning, then impacts would be expected. Overall, given the low buprofezin usage seen in the available data for olives, about 1% PCT, effective alternatives to buprofezin seem to be available, so the impacts from this mitigation on olive producers are expected to be small (USDA NASS 2011-2015, CDPR 2011-2015).

Nursery Ornamentals

To reduce post application risks to workers, EPA is considering an increase of the REI, currently 12 hours, to 1 day for handset irrigation activities for nursery ornamentals. The increase in REI for nursery ornamentals for handset irrigation activities from 12 hours to 24 hours is not expected to have high impacts on growers. The handset irrigation application method is not commonly used in ornamentals as most of the irrigation facilities are permanent structures.

Impacts for REIs greater than 48 hours

For any REI of 48 hours or more, there may be impacts due to posting requirements from the Worker Protection Standard (EPA 2015). The requirement to post and remove signage around the perimeter of the treated field will result in direct increases in time and labor costs and will likely decrease the ease of use that buprofezin currently offers to growers.

Increase in Personal Protective Equipment (PPE)

To reduce risks to handler from mixing/loading/applying buprofezin under certain scenarios, OPP is proposing increases in PPE. Backpack applications of water dispersible granules may be restricted to greenhouse use only with additional use of PPE, double layer (coveralls) and chemical-resistant gloves. Backpack applications of buprofezin were assessed on the following sites greenhouse tomatoes, greenhouse and nursery ornamentals, Christmas tree farms, and landscaping trees/shrubs/bushes/plants/flowers. BEAD does not have data on backpack applications of buprofezin. The impacts from restricting backpack applications is uncertain for Christmas tree farms and outdoor ornamentals (landscaping trees/shrubs/bushes/plants/flowers). The impacts of increasing the PPE for backpack applications to greenhouse sites is expected to be minimal since it is likely that many buprofezin users would have these items readily available.

Applicator spray via airblast to orchards/vineyards may have an increase in PPE of gloves and a chemical resistant hat. These increases in PPE should have low to no impacts since buprofezin handlers may already have this PPE available. Low impacts may be expected if buprofezin handlers need to purchase these items.

OPP is proposing to add respirators for handlers using soluble concentrates via fogging applications. If a buprofezin handler currently does not have a respirator, an additional cost will be incurred by the handler or the handler's employer, which includes the cost of the respirator plus the cost for a respirator fit test, training, and medical exam. Respirator costs are extremely variable depending upon the protection level desired, disposability, comfort, and the kinds of vapors and particulates being filtered. The estimated cost of a respirator fit test, training and medical exam is about $180 annually (EPA 2015).

No impacts are expected from the aforementioned increases in PPE if the buprofezin handler already has what is required available, otherwise low impacts are expected buprofezin handlers need to purchase these items.

Spray Drift Mitigation

To reduce ecological risks, OPP is considering adding spray drift language to buprofezin labels. Below BEAD discusses the potential impacts of such requirements.

Droplet Size

The Agency does not know how efficacy may be impacted when droplet size increases are required for various insecticides. Buprofezin is not systemic in plants and has both contact and vapor activity on target pests (Palumbo, 2001). Thus, requiring a medium or coarser droplet size on insecticide labels may undermine the Agency's effort to combat the evolution of insecticidal resistance and reduces grower flexibility to control a variety of target pests. This is especially a concern where there is a dense canopy (*e.g.*, cotton) and finer droplets are required to penetrate the canopy where the target pests reside (*e.g.*, whiteflies). The dependency of one route of exposure vs. another is variable by target pest and in some cases the target stage of development of that pest. These restrictions may also impact pre-mix or tank mix partners with less systemic chemical profiles or chemical adjuvants which may be rendered ineffective when applied at a larger droplet size.

Requiring medium or coarser droplets may result in:

- Reductions in efficacy with the potential for reductions in yield due to lower levels of pest control or for growers to use an alternate insecticide and/or encourage the evolution of insecticidal resistance;
- Increased costs associated with reduced yield, application technology updates, more insecticide applications, the purchase of alternatives products, or an inability to use tank mix or pre-mix products;
- Increased application rates or number of applications in response to reduced efficacy, resulting in higher production costs.

Although requiring increased droplet sizes could lead to higher costs for growers or control failures in certain situations, EPA does not know the specific impacts for droplet size restrictions on buprofezin. EPA encourages comments on any impacts to growers from increasing the droplet size to medium or coarser.

Wind Speed

The application windspeed restriction of no greater than 15 mph is currently present on buprofezin labels. Further restricting windspeed to 10 mph may decrease the days available during the growing season for applications and thus result in additional burdens to the grower.

Boom Height

The Agency is currently proposing to restrict applications made with boom sprayers to a maximum release height of 4 feet above the crop canopy or soil for ground applications and a maximum of 10 feet above the crop canopy or soil for aerial applications. BEAD expects that most users will face minimal impacts, however growers with equipment that does not meet the

requirement may have to pay for the cost to replace application equipment or the cost of re-fitting sprayers to accommodate these restrictions resulting from this mitigation.

Boom Width (aerial only)

For aerial applications, the Agency is proposing to require that the distance of the outer most nozzles on the boom must not exceed 75% of the length of the wingspan or 90% of the rotor diameter. For products that do not have a mandatory language on the label, the addition of swath width criteria for aerial applications may cause more passes to be made, make applications take longer and likely increase the cost of application. However, given that the available data suggests buprofezin is not applied aerially to a great extent within any registered crop, the impacts of this mitigation will likely be minimal.

CONCLUSION

Buprofezin is a chitin biosynthesis inhibitor, registered for use as an insect growth regulator (IGR) used to control primarily sucking/piercing pests on a variety of crops. Buprofezin offers high benefits to certain crops such as cotton, pears, and pistachios for control of key pests or pests with resistance issues within those production systems (*i.e.*, whitefly, pear psyllid and scale). Buprofezin is the only member of IRAC Group 16, and thus offers benefit to growers by providing an additional MOA for insect resistance management, particularly in crops such as pear where key pests (*e.g.*, pear psyllid) have a history of resistance issues.

OPP has completed human health and ecological risk assessments for buprofezin and identified several risks of concern. OPP is proposing mitigation to reduce these risks to bystanders, occupational handlers and ecological taxa. Overall the impacts of the proposed mitigations are expected to be limited. The highest impacts are expected from a few of the options proposed to reduce occupational handler risk. These potentially impactful options include increases in the REIs for certain use sites to reduce post application risk, and increases in PPE where a buprofezin handler must buy items for certain use sites if these items are not currently available to them.

Impacts of Bystander Risk Mitigation
To address bystander risks, OPP is considering prohibiting or limiting the application methods that pose risks, such as aerial applications to orchards and vineyards. Aerial applications of buprofezin are not common to orchard and vineyard crops, so low impacts overall are expected from restrictions on this method or its prohibition. Nevertheless, there does appear to be sporadic use of aerial application on some apple acres in certain locales (*i.e.*, Pennsylvania), so for these acres, the impacts may be larger. These buprofezin users may need to switch to alternative methods of application, e.g. ground, or use alternative methods of control if aerial restrictions make use of buprofezin too onerous.

Impacts of Occupational Handler Risk Mitigation
To address handler risks, OPP is considering prohibiting, limiting, and/or increasing the PPE for the application methods that pose risks, e.g., aerial, fogging, mechanically pressurized handgun,

and backpack applications. Aerial applications of buprofezin are not common to orchard and vineyard crops, so low impacts overall are expected. Low impacts are also expected from restrictions or prohibition of fogging and mechanically pressurized handgun applications, with the possible exception of greenhouse uses. No impacts are expected from the increases in PPE if the buprofezin handler already has it available (e.g. chemical gloves and hat, respirator and coveralls). If this is not the case, grower's will need to pay to purchase the PPE or select another insecticide. There may be increased costs or decreased efficacy from using alternative insecticides.

To address handler and field worker risks, OPP is additionally considering reductions in the application rate (pear) and increases in the REIs for certain sites (pome fruit, nursery ornamentals, grapes, olives and pears [higher application rate than other pome fruit]). The impacts of reducing the pear application rate to 1.6 lbs ai/acre are not expected to be high, due to the limited percentage of affected acres. Although pear psylla is currently controlled at rates less than 1.6 lbs ai/acre, there may be some concerns over resistance evolving in the future. For crops such as grape, to a lesser extent orchard crops (pome and stone fruit) and possibly olives, there are several cultural practices that need to take place in field (*i.e.,* leaf pulling, fruit thinning, training, propping, etc.). When the timing of those activities coincides with the need for insecticide applications, buprofezin may offer the best control option that minimizes delays entering the field with the current REI of 12 hours. Since buprofezin is an IGR and would be inefficacious if not applied at the proper timing relative to the target pest's life cycle stage, application would either take priority over whatever in-field activity needed to take place or growers will switch to an alternative if the REI is increased. For the proposed mitigation of increasing some REIs to as long as 8 days for certain crops (*i.e.,* pear) BEAD is uncertain what impacts may arise from delays to these in-field worker activities, if a suitable alternative is not available. In addition, there may be impacts from any REI that is over 48 hours, due to the posting requirements. The requirement to post and remove signage around the perimeter of the treated field will result in direct increases in time and labor costs and will likely decrease the ease of use that buprofezin currently offers to growers.

Impact of Spray Drift Mitigation (ecological taxa)
Requiring medium or coarser droplet sizes on insecticide labels may undermine the Agency's effort to combat the evolution of insecticidal resistance and reduces grower flexibility to control a variety of target pests. Other proposed spray drift mitigation such as boom and aerial spray release height requirements are expected to have low or limited impacts.

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