EPA Inquiry

Information on Critical and High Benefit Uses for Three Organophosphate Insecticides: Malathion, Acephate, and Dimethoate
Response Date: September 14, 2023

Request from EPA: August 18, 2023

"Several OPs are moving and we were hoping that you could provide some high-level benefit information to help BEAD scope our documents for our work on malathion, acephate, and dimethoate. If you could provide information on key pests/use sites for each AI (and possibly regional niche uses), that would be greatly appreciated. If you have supporting information to include, that is appreciated, but BEAD is also willing to do some digging if we knew what that critical/important uses were. We think it would be nice to have critical or other high benefit uses to focus on for the PID phase.

- What are the critical use sites for each OP and why (e.g., only efficacious active ingredient for a given pest/use site/region)?
- What are the important use sites for each OP and why (e.g., only effective OP for a given pest/use site/region)?"

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USDA Summary of Reference Materials and Expert Responses

General USDA Comments: On multiple occasions from 2020-2023, USDA has reached out to University Research, Extension, Commodity, and Crop Production experts from around the country via the Minor Crop Farmer Alliance for information about the remaining important uses of organophosphate (OP) insecticides. USDA recognizes that OPs present unique regulatory challenges and that declining overall use reflects that growers have an increasing number of reduced-risk tools at their disposal and are largely transitioning away from widespread OP reliance. However, for some specific use patterns and pest scenarios, OPs still have significant agricultural importance for some producers. The synthesis of material presented herein represents consensus feedback from these experts as reported to USDA in numerous meetings, teleconferences, email summaries, one-on-one discussions, and other personal communications from 2020-2023. Because numerous use patterns for these products are localized and niche, this direct expert feedback is the best (or sometimes the only) insight into the relatively few remaining critical and high benefit pest management needs for this group of insecticides. Upon request, USDA is happy to share specific names and contact information for these experts with EPA and/or facilitate follow-up questions or discussions. To the extent possible, we also cite available published extension guidance, pest management strategic plans, IPM recommendations, and other publicly available information, and we have also cited available proprietary pesticide usage data where possible, mainly via internal foot-noting with applicable links provided).

First, we below present a summary table that groups the uses of most concern (by the three chemicals of interest) between critical needs and high benefit uses. For the purposes of discussion with EPA, USDA is defining "critical uses" as those where a given chemical is the only viable chemical control option for many growers. This means that the chemical cannot be easily or practically replaced by currently available alternatives. While a designation of "critical" does not necessarily mean that the chemical is needed by all growers in all regions, it does represent a need that cannot be replaced at this time for growers facing certain specific pest challenges. Where applicable, the need may be categorized as regional or for a specific part of a crop's growing season where available alternatives are either unavailable or ineffective. Designation of "important" uses are for scenarios where alternatives may exist, but a given chemical offers specific advantages or represents the only OP option for a given use (i.e., important for management of resistance to alternatives). Where appropriate, we also include information on other related OP insecticides of regulatory interest, for context on how they interact within the larger IPM system for some crops.

Critical and Important Use Table for Acephate, Dimethoate, and Malathion as of 2023

Chemical	Critical Needs	Important Uses
Acephate	Cotton Peanuts Cranberries (PNW only)	Mint Leafy Vegetables, Celery Tobacco Ornamentals, Non-Ag Spot Treatments Soybeans (SLN for LA, MS, AR, and TX) Sod <u>Seed Crops</u>: Oregon, CA, WA seed alfalfa SLN for Lygus; Oregon Carrot seed SLN for Lygus and Green Peach Aphid WA Radish seed SLN for aphids, diamond-back moth, etc. Pine seedling production (NC only)
Dimethoate	Safflower Beans/Peas/Pulses (fresh and dry) Asparagus	Cotton--niche Leafy Vegetables Alfalfa Citrus Potatoes Tomatoes Pine seedling nurseries Christmas trees Sorghum Wheat Sunflowers (potentially)
Malathion	Blueberries, Caneberries, Strawberries, Cherries, Other Berries (SWD, broad-spectrum pest control) Figs Pine Seed Orchards (thrips) APHIS crickets/grasshoppers APHIS Texas Cotton BW eradication APHIS Invasive fruit fly bait products, aerial applications Mosquito adult control (ground)[1]	Citrus Cucurbits Tropical fruits (niche uses, critical for pineapple) Alfalfa/hay forage crops Pine seedling propagation (sawfly) Mushrooms (indoor) Beets (CDFA)—curly top virus Vegetables

[1] USDA has no comments on mosquito uses and defers to the American Mosquito Control Association (AMCA) for specifics. We list this use for context, noting that naled is the primary mosquito adulticide tool used for aerial treatments while malathion is more commonly used for ground applications, based on prior AMCA feedback.

Cotton: Acephate, Malathion (BWEP), Dimethoate

Acephate, dicrotophos, and tribufos are all identified as critical needs for cotton, based upon available AMRD (2017-2021) and repeated emphasis on these three active ingredients in communications from the National Cotton Council and extension experts from Mississippi State University, Louisiana State University, University of Tennessee, University of Missouri, and University of Arkansas. BEAD has done multiple prior draft assessments covering Lygus management in cotton, in support of neonicotinoids, pyrethroids, sulfoxaflor, flupyradifurone, and other active ingredients, which are all essential in managing tarnished plant bugs in the Mid-South. As BEAD has previously concluded, a variety of AIs and modes of action are needed for a robust rotational toolbox to manage pest populations and incidence of insecticide resistance. BEAD previously did a dicrotophos assessment (https://www.regulations.gov/document/EPA-HQ-OPP-2008-0440-0032) and identified it as a critical need for Lygus control, but industry stakeholders have also emphasized its importance for managing stink bugs, along with acephate.

This is important context for considering the critical need for acephate in cotton production—while acephate alternatives are available for some pests, the cotton industry has emphasized to USDA that because of the variety and magnitude of pest pressure, especially in the Mid-South U.S., all of these chemicals are needed and widely used, and the loss of acephate cannot be offset by availability of these alternatives (National Cotton Council and Regional Extension Experts, pers. comms. to USDA). Further, because acephate is systemic, its efficacy is particularly good in comparison to alternatives like pyrethroids. It is generally regarded as the most widely effective option for thrips, plant bugs, stink bugs, beetles, whiteflies, aphids, as well as lepidopteran pests (National Cotton Council, pers. comms. to USDA).

Evidence of acephate's critical importance for cotton is confirmed by available usage data, as it is the market-leading insecticide choice by total treated annual acreage on cotton by a wide margin (ARMD 2017-2021). Beyond efficacy against Lygus, thrips, and fleahoppers, it is also very effective against stink bugs. This benefit of stink bug management varies somewhat by region, as stink bug damage in the Mid-South is a causal agent for boll rot infection. This is the primary economic driver of stink bug control, as the direct feeding damage is usually minimal, and almost always a non-factor in more arid production regions such as Arizona and California (University of Arizona, National Cotton Council, pers. comms. to USDA).

While dimethoate has some niche value in cotton for Lygus and thrips control under lower pressure situations, experts have conveyed to USDA that it is not an adequate potential replacement for any other OP AIs such as dicrotophos or acephate (National Cotton Council, pers. comms. to USDA) from a broad-spectrum efficacy standpoint. Usage of naled has some niche importance for cotton, mainly for use in California and Arizona (University of Arizona, pers. comm. to USDA), but it is not widely effective in other regions for control of Lygus or thrips. USDA submitted comments (https://www.regulations.gov/comment/EPA-HQ-OPP-2009-0209-0032) to the naled risk assessment and discussed the benefits of naled for cotton grown in California under SLN.

Finally, malathion remains a critically important tool in the Texas boll weevil eradication programs, supported by APHIS. This is a long-standing program to maintain weevil-free zones along the southern U.S. border (https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/cotton-pests/boll-weevil-resources).

Blueberries, Strawberries, Caneberries, other Berries, Cherries: Malathion

Malathion for spotted wing drosophila (SWD) control is a critical IPM need across all of these crops, due to utility near harvest and international MRL compatibility with major export markets. For nearly a decade, USDA has participated in the stakeholder advisory panel for the SWD working group, which brings together leading entomologists, researchers, and IPM experts across the country. Across all of these crops, universal expert consensus has been expressed to USDA regarding the critical need for malathion and other insecticide tools for SWD management. While myriad malathion alternatives are available for berries and cherries that are effective against SWD, few (if any) active ingredients provide the pre-harvest interval (PHI) flexibility that malathion does. This is reflected in available AMRD (2017-2021), which shows that malathion is not a market-leading tool. However, the important nuance in this discussion is to understand malathion is one of very few options with a short enough PHI to control SWD through harvest with the accompanying MRL compatibility for major U.S. export markets. For blueberries and cherries, MRL considerations are a particular concern, given the level of exports to Canada and elsewhere (Michigan State University extension, Washington State University extension, Northwest Horticultural Council, pers. comms. to USDA). Continued availability of malathion (among other tools) on cherries and all of these listed berry crops is a critical need for areas under significant SWD pressure.

Phosmet is also a critical need in blueberries and tart cherries for control of plum curculio, maggots, and also earlier season control of SWD. Michigan stakeholders note that IPM programs for SWD would crumble without phosmet and malathion. Both malathion and phosmet are compatible with MRL limitations that eliminate the feasibility of some pyrethroid alternatives. USDA confirmed that these two products are the most critical needs for 'lowbush' blueberry producers, mostly located in Maine, for controlling SWD (University of Maine, pers. comms to USDA).

For strawberries, UC-IPM pest management guidelines recommend malathion as the number one IPM option for control of SWD in California, when populations warrant treatment (https://ipm.ucanr.edu/agriculture/strawberry/spotted-wing-drosophila/#:~:text=Spotted%2Dwing%20drosophila%20is%20found,and%20other%20soft%2Dfleshed%20fruits). Malathion and naled both also show significant usage targeting Lygus. USDA has previously commented on the benefits of naled under the risk assessment comment period, cited previously. Depending upon the outcome of sulfoxaflor decisions for strawberries, the relative importance of malathion and naled could further increase. While not currently registered, stakeholders have previously petitioned EPA for use of methomyl for post-harvest control of Lygus on California strawberries. Given the successful outcome of the methomyl PID, USDA

would be interested in scoping what might be possible to restore use on strawberries as a post-harvest tool for Lygus.

A recently published 2021 PMSP is available for blackberries in the Southern US: https://ipmdata.ipmcenters.org/source_report.cfm?sourceid=1444&view=yes

A 2012 PMSP for Michigan tart cherries is available here, but USDA notes that the discussions of malathion are out of date, since SWD only arrived in Michigan in 2010-2011: https://ipmdata.ipmcenters.org/documents/pmsps/MITartCherryPMSP.pdf

A 2018 PMSP for PNW sweet cherries is available here: https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9219.pdf

Cranberries: Acephate (PNW only)

Acephate is reported by the Cranberry Institute to be a critical pest management need for growers in Washington, for control of fireworms, tipworms, and cranberry girdlers. However, acephate is not widely used in the eastern United States. USDA lists acephate as a critical need based on personal communications from the Cranberry Institute and also based upon the listing of acephate as a leading effective material against blackheaded fireworms by Washington State University Extension Guidance (https://pnwhandbooks.org/insect/small-fruit/cranberry/cranberry-blackheaded-fireworm). Similar extension guidance indicated that no chemical tactics were currently listed as effective for cranberry girdlers (https://pnwhandbooks.org/insect/small-fruit/cranberry/cranberry-cranberry-girdler), but acephate was discussed as one viable tactic by the Cranberry Institute via personal communications. Further, acephate is listed as the number one recommendation for cranberry root weevils (https://pnwhandbooks.org/insect/small-fruit/cranberry/cranberry-root-weevil) and it is notable that it is the only active ingredient identified as effective across the board for this pest. As such, USDA believes that acephate should be categorized as critical, as it may represent the only viable broad-spectrum insecticide option for some growers in the PNW for root weevils. Additional information on IPM needs for cranberries grown in PNW is available at the links below.

2018 PMSP: https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9212.pdf

Washington State University: https://longbeach.wsu.edu/cranberries/cranberry-ipm-and-insect-pest-information/

Citrus: Malathion, Dimethoate

Malathion, carbaryl, dimethoate, phosmet, and naled, are all useful components of broad-spectrum control of adult stages of Asian Citrus Psyllid (ACP), and this situation is well-understood by BEAD. In general, the availability of these OP and carbamate options are critical in the aggregate for addressing exigent and new pest scenarios, including invasive species

(California Citrus Quality Council, pers. comms. to USDA). Stakeholders, particularly extension experts from University of Florida and Florida Fruit and Vegetable Association (pers. comms. to USDA) have repeatedly expressed concern that losing too many of these options will put untenable pressure on pyrethroids for resistance management, especially for pests where pyrethroids aren't adequately effective. Critically, malathion, especially when used in bait products, is a keystone tool in APHIS' numerous programs to address invasive fruit fly species impacting citrus and other tropical fruits (https://www.aphis.usda.gov/plant_health/ea/downloads/2018/fruitfly-final-eis.pdf).

Figs: Malathion

Malathion is the only available tool for controlling dried fruit beetle. Applications also provide some incidental control of navel orange worms and vinegar flies. USDA concludes this need is critical due to the lack of viable chemical alternatives, as discussed in published Extension recommendations for dried fruit beetle management on figs (https://www2.ipm.ucanr.edu/agriculture/fig/Driedfruit-beetles/).

Tropical Fruits: Malathion

USDA received feedback from the Florida Fruit and Vegetable Association and University of Florida tropical fruit extension experts indicating that malathion is important for scale control and other broad-spectrum pest control needs for specialty tropical crops (University of Florida, pers. comms. to USDA, 2021). In particular, an extension expert noted that malathion is an important rotational product for use on avocado, citrus, guava, mango, papaya, passionfruit, and pineapple. Retaining flexibility on the number of applications per season is especially important for crops like guava, which is vulnerable to pest infestation for up to 7 months between flowering and harvest for pests such as Caribbean fruit flies. While alternatives are available in some cases, this long period of vulnerability means that seasonal maximum limits may be exhausted for multiple compounds and relatively few are registered for these uses. This makes retention of malathion especially important (University of Florida, pers. comms. to USDA, 2021).

An extension expert from the University of Hawaii-Manoa specifically indicated to USDA that malathion (along with flupyradifurone and imidacloprid) were important for control of the recently introduced avocado lace bug (University of Hawaii, pers. comms. to USDA, 2021). We note that essentially all of the existing malathion uses for tropical fruits were retained during EPA/FWS/NMFS consultation discussions, with some minor rate reductions proposed for citrus. Critically, malathion, especially when used in bait products, is a keystone tool in APHIS' numerous programs to address invasive fruit fly species impacting citrus and other tropical fruits (https://www.aphis.usda.gov/plant_health/ea/downloads/2018/fruitfly-final-eis.pdf).

Finally, a representative from Dole (pers. comms. to USDA) indicated that for pineapples grown in Hawaii, malathion is a critical need for control of mealybugs. It is applied 3 times per year at

max label rate and the reason it is a critical need is that the main alternative, diazinon, has an uncertain future. While growers are evaluating spirotetramat as an alternative, it is going to be far more costly per acre, with unknown efficacy compared to malathion (Dole, pers. comms. to USDA).

To date, no critical needs for malathion have been identified for macadamia nuts, coffee, or dates. Historically, USDA is generally aware that malathion dust has been used to manage carob moth on dates; however, the registration of methoxyfenozide may have helped reduce the need for this use.

For more information on tropical fruit IPM, USDA suggests working with OPMP to consult IPM experts at the University of Florida's Tropical Research and Education Center https://trec.ifas.ufl.edu/ and experts at the University of Hawaii-Manoa.

Asparagus: Dimethoate

While past dimethoate usage has been moderate on asparagus (AMRD, 2017-2021), there is reason to predict that dimethoate benefits could increase substantially. USDA bases this contention on feedback from Washington State extension experts and the Washington State Asparagus Commission (pers. comms. to USDA). Chlorpyrifos provided unique benefits because it was effective against both beetles and aphids in one single application. Without chlorpyrifos, dimethoate's efficacy against aphids becomes a much more critical need, especially if sulfoxaflor is lost due to its ongoing litigation uncertainty. In the absence of chlorpyrifos, many asparagus growers will likely need to use a tank-mix combination of dimethoate (for aphids) and carbaryl (for beetles) to achieve similar efficacy previously offered by one active ingredient. Designation as a 'critical' need is perhaps subjective here, since it depends upon the availability of sulfoxaflor for aphid management. Overall, retention of dimethoate will be important to avoid over-reliance on pyrethroids (or sulfoxaflor) and eventual resistance development (Washington State Asparagus Commission, pers. comms. to USDA, 2023).

Beets (Curly Top Virus): Malathion

The California Specialty Crops Council (pers. comms. to USDA) has emphasized the importance of malathion use on beets and other vegetable crops for control of beet leafhoppers that vector beet curly top virus, which is the subject of a statewide management program in California (https://www.cdfa.ca.gov/plant/ipc/curlytopvirus/ctv_hp.htm).

Potatoes: Dimethoate

Dimethoate is among the leading options for aphid management (AMRD, 2017-2021), but usage targeting psyllids, leafhoppers, and thrips is also important (Washington Potato Commission,

pers. comms. to USDA). As is discussed for pulses and tomatoes, the cost-effectiveness and long-residual efficacy of dimethoate makes it a highly valuable tool for growers.

A 2020 PMSP for PNW potatoes is available here:
https://ipmdata.ipmcenters.org/documents/pmsps/ID-OR-WAPotatoPMSP2020.pdf

Beans/Peas (fresh): Dimethoate, Acephate

Dimethoate is a primary tool for aphids, leafminers, and whiteflies (AMRD, 2017-2021). Acephate is also sometimes used. Retention of an OP could be important for RM concerns to avoid over-reliance on pyrethroids, but broad-spectrum pest control options for fresh beans may be more tenable than for dry beans (National Pulse Council, pers. comms. to USDA). For aphid, leafminer, and whitefly management, usage of pyrethroids, neonicotinoids, spinosyns, and flupyradifurone exceeds usage of acephate or dimethoate, but these are the two leading OP insecticide choices for these pests (AMRD, 2017-2021).

Beans/Peas (dry), Pulses: Dimethoate

Dimethoate is the market leading insecticide for aphid and Lygus control (AMRD, 2017-2021). It is superior to alternatives due to systemic activity and long residual efficacy. Experts from the National Pulse Council (pers. comms. to USDA) emphasized that dimethoate is so useful because it provides 30 days of efficacy that often precludes the need for multiple applications of alternative active ingredients, especially for aphids and plant bugs in the Northern Great Plains. This utility is of special concern to growers because dry pulse crops are generally low profit-margin systems. If multiple applications of less effective alternatives become necessary to replace dimethoate, costs can quickly become untenable (National Pulse Council, pers. comms. to USDA), which leads to USDA's conclusion that this use is critical. California IPM recommendations also list dimethoate as the most highly recommended OP insecticide for control of Lygus bugs (https://ipm.ucanr.edu/agriculture/dry-beans/lygus-bugs/).

Dimethoate is also sometimes used for weevils. Retention of an OP could be important for RM concerns to avoid over-reliance on pyrethroids. Phosmet was also identified as an important need for weevils (pea weevils and seed pod weevils) but appears to rank behind dimethoate in overall usage. Carbaryl is a niche need in areas with exposure to grasshoppers. Based on the carbaryl PID, this need appears to be adequately addressed.

A PMSP from 2017 is available for dry beans/peas:
https://ipmdata.ipmcenters.org/documents/pmsps/2016PulsePMSP_FINAL.pdf

Tomatoes: Dimethoate

Dimethoate is the market-leading OP choice for aphids and leafhoppers (AMRD, 2017-2021), and is important for resistance management, since neonicotinoid use might be further restricted.

Similar to the discussion for dry beans, the highly effective, systemic, cost-effective and long-term efficacy make dimethoate critically important for growers (Minor Crop Farmer Alliance, pers. comms. to USDA). Dimethoate is also among the market leading options for thrips (AMRD, 2017-2021) and also has good utility for flea beetles. While California extension recommendations do not list dimethoate as the leading recommendation for aphid control on tomatoes (https://ipm.ucanr.edu/agriculture/tomato/green-peach-aphid/#:~:text=The%20green%20peach%20aphid%20and,transmit%20virus%20diseases%20to%20tomatoes; https://ipm.ucanr.edu/agriculture/tomato/potato-aphid/), or for thrips (https://ipm.ucanr.edu/agriculture/tomato/thrips), Minor Crop Farmer Alliance and other stakeholders have emphasized to USDA that the cost-effectiveness and length of efficacy make it a highly important use to retain.

A recently revised PMSP for tomatoes is available here: https://ipmdata.ipmcenters.org/source_report.cfm?sourceid=1383&view=yes

Mushrooms (Indoor Production): Malathion

USDA received input from a Penn State University mushroom IPM expert (pers. comms to USDA), who indicated that malathion usage is relatively low for most producers. Malathion can be used for pests such as mites, phorids, and sciarids. Because all mushroom production is done indoors, ecological exposure concerns are not relevant for insecticide use on mushrooms. Malathion is a knockdown tool, but does not provide great residual efficacy, and most of the industry is using alternatives such as synthetic pyrethroids. However, USDA suggests that retention of malathion is important so that over-reliance on pyrethroids does not lead to resistance concerns. Industry is actively pursuing alternatives for fly control, as large outbreaks are problematic for neighboring residential communities and not just mushroom producers.

Extension publications on fly control for mushroom production are available here: https://extension.psu.edu/phorid-fly-in-commercial-mushroom-production

https://pnwhandbooks.org/insect/vegetable/mushroom/mushroom-mushroom-fly

Minor Specialty Vegetables, Herbs, and Miscellaneous Specialty Crops (Foliar Treatments): Malathion

Generally, historical California usage data indicate that methomyl, naled, and malathion are some of the more widely used insecticides for general broad-spectrum insect control in specialty vegetable crops, including herbs (California Specialty Crops Council, pers. comms. to USDA). EPA can confirm this assertion with more recent data. Based on EPA's methomyl and carbaryl PIDs, the continued use of these tools appears to be retained. USDA has previously commented on risk assessments for naled (cited previously), with discussions of key uses of importance. USDA suggests that malathion's benefit for broad-spectrum pest management is probably consistent across most specialty vegetable crops, based upon broad stakeholder feedback from

extension experts and commodity representatives for leafy greens, fruiting vegetables, etc. as well as from data collected in USDA's pilot pesticide use survey for malathion, completed in Autumn, 2021 (fact sheet previously shared with EPA).

Non-Brassica Leafy Vegetables (Lettuce, Spinach, Celery, etc.), Cucurbits, and Peppers: Acephate, Dimethoate

Acephate and dimethoate are important needs for Lygus bug and aphid control in lettuce and other leafy greens. Acephate is also used for aphid and thrips management as part of a rotation of available alternatives, including methomyl. Acephate and dimethoate are useful on celery to control aphids (AMRD, 2017-2021). Experts (Minor Crop Farmers Alliance, California Specialty Crops Council, pers. comms. to USDA) have stated that the main benefits of acephate and dimethoate on these crops is inexpensive, reliable, and persistent efficacy compared to alternatives. USDA suggests these benefits could increase if neonicotinoid uses on leafy vegetables become more restricted.

A 2020 PMSP for California and Arizona lettuce is available here: https://ipmdata.ipmcenters.org/documents/pmsps/CA-AZLettuce%20PMSP-2020.pdf

For peppers, acephate and dimethoate are used to control weevils and aphids. Thiamethoxam is a leading option for pepper weevils and may be lost due to proposed bloom restrictions for neonicotinoids. As with leafy vegetables, restrictions on thiamethoxam could significantly increase the need for growers to have oxamyl, acephate, and/or dimethoate as a back-up tactic for control of pepper weevils and aphids (Minor Crop Farmers Alliance, California Specialty Crops Council, University of Georgia, pers. comms. to USDA).

For cucurbits, USDA's pilot malathion survey, discussed above, indicated that use was important for beetle management and other broad spectrum pest control needs.

A 2016 PMSP for California melons is available here: https://ipmdata.ipmcenters.org/documents/pmsps/2016%20CA%20Melon%20PMSP.pdf

Mint: Acephate

Acephate is reported to be important for mint production, for control of armyworms, mint root borers, and cutworms (https://pnwhandbooks.org/insect/agronomic/mint; Mint Industry Research Council, pers. comms. to USDA). Acephate is notably the number one recommendation for efficacy against mint aphids (https://pnwhandbooks.org/insect/agronomic/mint/mint-aphid). Acephate applied by chemigation is also particularly effective at controlling late-season armyworm infestations, as conveyed to USDA from Washington State University extension experts and the Mint Industry Research Council. USDA has previously commented on the benefits of chlorpyrifos for mint and noted that it was particularly important for control of mint root borers. Industry stakeholders estimated that approximately 30% of mint acreage was treated with chlorpyrifos annually prior to cancellation (Mint Industry Research Council, pers. comms.

to USDA). In the absence of chlorpyrifos, growers are likely to rely on less effective materials, including acephate to control mint root borers.

Peanuts: Phorate, Acephate

Phorate is a critical need for thrips control at planting, especially when vectoring of tomato spotted wilt virus (TSWV) is a concern. USDA previously submitted comments (https://www.regulations.gov/comment/EPA-HQ-OPP-2009-0055-0019) in response to the phorate ecological risk assessment, noting that phorate provides special efficacy benefits for virus control that alternatives do not offer. Acephate also remains a critical need for foliar management of thrips in the long growing season. The reason USDA lists acephate as a critical need for peanuts is that it provides in-season foliar thrips efficacy to complement the efficacy provided by pre-plant applications of phorate. Extension experts from Auburn University and University of Georgia (pers. comms. to USDA) argued that both of these active ingredients are critical needs for season-long efficacy. This is also reflected in published UGA extension recommendations, which indicate acephate is the only viable tool when pre-plant application efficacy "runs out of steam" (https://www.agfax.com/2017/04/17/georgia-peanuts-5-thrips-management-options/).

Sorghum: Dimethoate

Dimethoate is among the market leading insecticide tools for stink bug control on sorghum, along with pyrethroids and sulfoxaflor, which is also used to target sugarcane aphids (AMRD, 2017-2021).

A 2020 PMSP for sorghum grown in the southern United States is available here: https://ipmdata.ipmcenters.org/source_report.cfm?view=yes&sourceid=1449.

Soybeans: Acephate

Acephate is among the market leading options for stink bug control along with pyrethroids and neonicotinoids (AMRD, 2017-2021). Retention of acephate could provide resistance management benefits going forward, since it would be the only effective OP insecticide available for use in rotation or in tank-mix combinations with pyrethroids and neonicotinoids. USDA notes that a number of southern states have SLN registrations for acephate on soybeans and that LSU extension guidance lists acephate as the number one recommended option for stink bug control (https://www.lsuagcenter.com/articles/page1663767685378). Texas A&M extension guidance has a similar recommendation (https://agrilife.org/mid-coast-ipm/2018/05/21/stink-bugs-in-soybeans/).

Sunflowers: Dimethoate

BEAD has assessed the use of chlorpyrifos on sunflowers, which was the main OP insecticide of significance for this crop based on usage (AMRD, 2017-2021). While dimethoate shows some usage against seed weevils, efficacy is unclear. If dimethoate is effective, there is potential for benefits to increase moving forward.

Tobacco: Acephate

Acephate is the market-leading OP insecticide option for aphid and flea beetle control in tobacco and is also widely used for control of budworms and hornworm (AMRD, 2017-2021). For lepidopteran pests, chlorantraniliprole, *Bt*, and spinosad are effective alternatives, but acephate has high benefits for control of aphids and flea beetles. Chlorpyrifos was also used historically on tobacco, and this benefits profile has been previously assessed by BEAD. USDA notes that in the absence of chlorpyrifos, acephate may take on increased importance.

Wheat: Dimethoate

Dimethoate is used on wheat, but pyrethroids are the market leaders (AMRD, 2017-2021). With the loss of chlorpyrifos for all food uses, retention of dimethoate on wheat is important for resistance management, particularly for aphids.

Minor Grains and Oilseed Crops: Dimethoate, Naled

The most prominent example of a crop from this group that is highly dependent on OP insecticides is safflower. Safflower is mainly grown in California. While it is not a high value crop, it serves as a useful rotational crop, particularly for water and nutrient management purposes while providing at least some return to growers when harvested as a crop. Historical Cal-PUR data indicate that around 40% of safflower is treated with dimethoate and around 75% is treated with naled, mainly for Lygus bugs, stink bugs, and beet leafhoppers that directly impact yield. EPA can confirm this assertion with more recent data. Particularly for Lygus, growers have adopted area-wide IPM tactics to make better use of the low number of available insecticides, discussed further at the Western IPM Center link below. USDA has previously commented on the benefits of naled in safflower for the naled/DDVP/trichlorfon risk assessments (cited previously). It is notable that safflower only has two OP insecticides (naled and dimethoate) registered for use along with one pyrethroid, for the entirety of pest control needs. While it is not ideal that all pest management on this crop relies on broad-spectrum options, the net result is that dimethoate (along with naled) is a critical need because of this situation.

More information is available from the Western IPM Center here: http://westernipm.org/index.cfm/ipm-in-the-west/agriculture/safflower-makes-an-areawide-ipm-program-work/.

A 2016 PMSP for safflower grown in California is available here: https://ipmdata.ipmcenters.org/documents/pmsps/CASafflowerPMSP2016.pdf

Alfalfa (forage): Dimethoate

Weevils and aphids are among the most common pests treated in forage alfalfa production systems (AMRD, 2017-2021). Chlorpyrifos was one of the most commonly used treatments for both these pests, though pyrethroids are also widely used (including products that co-formulate chloryprifos with a pyrethroid). Indoxacarb, and sulfoxaflor are effective alternatives for some growers but both tend to be relatively expensive alternatives. Based upon expert feedback from extension experts, USDA expects that dimethoate benefits will increase with the loss of chlorpyrifos, particularly for control of aphids. BEAD has assessed chlorpyrifos benefits and OPMP previously submitted comments in response to the PID, which proposed to retain alfalfa use in most states. A discussion of pest management needs for alfalfa seed production is provided separately.

Alfalfa, Grass, and Vegetable Seed Production: Naled, Dimethoate, Acephate

Most production of forage seed (including alfalfa), grass seed, and vegetables grown for seed is concentrated in the PNW. USDA previously submitted comments to EPA's chlorpyrifos PID on the importance for this seed production sector, citing extension experts from Washington State University, Oregon State University, and a board member from the National Alfalfa and Forage Alliance. While usage of other OP and carbamate insecticides remains somewhat important, newer alternatives have gained adoption, particularly in production systems where alfalfa is grown for seed. USDA previously commented on the importance of naled for Lygus control in alfalfa grown for seed as well as for other grasses and vegetables grown for seed (cited previously). For acephate, USDA notes that acephate SLN labels are in place for numerous grass, forage, and vegetable seed crops in Washington, Oregon, and California for broad-spectrum pest control, for which we can conduct additional outreach on a case-by-case basis.

Similar to what was discussed for alfalfa grown for forage, USDA contends that the in the absence of chlorpyrifos, the importance of dimethoate may increase substantially, especially for instances where aphid management is needed (Washington State University extension; National Alfalfa and Forage Alliance, pers. comms. to USDA). Dimethoate is also effective and inexpensive for alfalfa weevil management, so again could see an increase in usage with the loss of chlorpyrifos.

A 2017 PMSP for alfalfa seed production is available here: https://ipmdata.ipmcenters.org/documents/pmsps/AlfalfaSeedPMSP_FINAL.pdf

Sod Farms/Commercial Turf: Acephate

USDA received feedback on sod farm insect control from extension experts at Texas A&M University, University of Florida, Clemson University, and University of Georgia (pers. comms. to USDA). Generally, OP/carbamate usage and importance has decreased on turf over the years, as alternatives such as neonicotinoids and diamides have gained adoption. USDA has previously submitted comments on chlorpyrifos to EPA's PID and on trichlorfon to EPA's risk assessment. Acephate, trichlorfon, and carbaryl are the main active ingredients still used by sod farmers. The main benefit of these active ingredients for sod farms is that they are low cost. These broad-spectrum materials are also valuable for rescue treatments in fields where grubs, billbugs, etc. have grown to larger stages, at which point narrow-spectrum alternatives are less effective. This can be most important right before sod harvest, as billbug damage can cause sod pieces to fall apart during harvest, so a rescue treatment is applied to prevent this damage. While acephate has some importance for these uses, USDA's synthesis of extension expert feedback does not lead us to characterize acephate as a critical need for sod producers or commercial turf managers at this time. However, this conclusion depends on continued availability of one or more broad-spectrum alternatives such as trichlorfon, carbaryl, or chlorpyrifos.

Ornamentals/Nursery Stock/Christmas Trees: Chlorpyrifos, Acephate, Dimethoate

Feedback from American Hort (pers. comms to USDA) and available extension information generally indicates that the usage of OP has decreased in commercial ornamental and nursery production over time. However, some niche uses are still important. For instance, chlorpyrifos suppresses Red Imported Fire Ants via treatment of balled and burlaped nursery stock, and this use is supported by USDA-APHIS. Hand-gun application of chlorpyrifos effectively controls borer pests on trunks in nurseries. Acephate has broad-spectrum activity against pests such as aphids, adelgids, stink bugs, and leafhoppers. Dimethoate still has some importance in Christmas tree production for control of adelgids, and mites and on other ornamentals for control of aphids, scales, leafhoppers.

A 2015 PMSP for ornamental production in the Southern United States that summarizes insecticide use information is available here:
https://ipmdata.ipmcenters.org/documents/pmsps/SNIPMnurserycrops2015.pdf

Pine Seed/Seedling Production: Malathion, Acephate, Dimethoate

USDA-Forest Service has previously provided EPA with a briefing paper (2020) on the importance of malathion for control of slash pine flower thrips in pine seed orchards in the Southern U.S. During the critical January-February timing of flower opening in the Southern U.S., malathion is a critical need for thrips management by aerial applications on slash pines and has been used for decades by U.S. Forest Service (USFS, pers. comms. to USDA). Acephate is also important but as of early 2023, was registered only for use in North Carolina. For pine seed production outside of North Carolina, malathion is the only available effective for thrips (USFS, pers. comms. to USDA). For seedling production, experts also report to USDA that acephate and

malathion are the leading OP options for control of pine sawflies, and pyrethroids are the main OP alternatives. Acephate also has utility for control of aphids on pine seedlings, along with neonicotinoids and pymetrozine.

USDA also notes that dimethoate is the only alternative to chlorpyrifos for control of lesser cornstalk borers on pine seedlings, according to a recently published PMSP for southern pine tree nursery production, which also addresses the sawfly and aphid situations discussed above: https://ipmdata.ipmcenters.org/source_report.cfm?sectionid=7&controltypeid=0&sourceid=2475

Pasture/Rangeland/Conservation: Malathion, Acephate

Malathion and carbaryl are both critical needs for public and private programs aimed at controlling Mormon crickets and grasshoppers in rangelands and ag-adjacent lands in the western United States. The only alternative for these applications is diflubenzuron, which only targets nymphs. Malathion and carbaryl are effective against both nymphs and adults, making timing precision less critical. USDA-APHIS and a number of states coordinate efforts to prevent area-wide outbreaks of crickets and grasshoppers in order to protect pasture and agricultural crop production areas.

USDA also received input from extension experts at the University of Hawaii regarding the importance of malathion for pest control in pastures. Malathion is an important tool for early outbreak spot-treatment of armyworms, webworms, and two-lined spittlebugs (University of Hawaii-Manoa, pers. comms. to USDA, 2021).