OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

WASHINGTON, D.C. 20460

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MEMORANDUM

SUBJECT: Mancozeb (PC 014504) Registration Review: Assessment of Foliar Use, Usage, and Benefits in Ginseng and Field Crops with Assessment of Impacts of Potential Mitigation in Ginseng, Potato, Sugarbeet, and Sweet Corn

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SUMMARY

Mancozeb is a broad-spectrum multisite fungicide registered for many agricultural and non-agricultural uses. This memorandum describes the use, usage, and benefits of mancozeb as well as impacts of potential mitigation to mancozeb users in ginseng and registered field crops (barley, corn (field, popcorn, and sweet), oats, peanuts, potatoes, rye, sugarbeets, tobacco, triticale, and wheat).

Usage data and public comments indicate that mancozeb is regularly used on ginseng, potatoes, sugarbeets, and Florida sweet corn. In these crops, mancozeb is used to prevent disease caused by fungal and oomycete organisms, including Alternaria leaf and stem blight in ginseng, early and late blight in potatoes, Cercospora leaf spot in sugarbeets, and leaf blights in sweet corn. When combined with other active ingredients, mancozeb provides enhanced control and prevents or delays resistance to highly efficacious but resistant-prone single site fungicides. Only one multisite alternative to mancozeb is recommended against each of these mancozeb target pests. BEAD finds that mancozeb has high benefits in ginseng, potato, sugarbeet, and Florida sweet corn production due to its efficacy against damaging pests, role in resistance management, and limited multisite fungicide alternatives.

Other registered field crop sites (*e.g*., field corn, peanuts, and wheat) reported minimal usage of mancozeb. This lack of usage suggests that growers either have other cost-effective tools available to control mancozeb target pests or the pathogens which mancozeb is effective against are not problematic in these use sites. BEAD concludes low benefits in these sites. BEAD additionally concludes likely low benefits for registered field crops not surveyed for usage data or identified as an important use site in public comments (*i.e*., oat, popcorn, rye, and triticale) due to similarities with other small grain crops where mancozeb has low benefits.

EPA has identified occupational human health risks of concern from use of mancozeb in ginseng and field crops. To reduce these risks, the Agency is considering increasing the reentry interval to 10-days for workers entering a field after a mancozeb application; for pesticide applicators, the Agency may require an Assigned Protection Factor 10 (APF10) respirator and use of double layer clothing and protective gloves; for workers mixing and loading pesticides, the requirement of a closed loading system is being considered when utilizing dry flowable and wettable powder formulations for use in aerial and chemigation applications. A closed loading system may entail the requirement that these formulations come in closed packaging that can be inserted into water in a pesticide delivery system and mixed with the container closed. The Agency is also considering disallowing use of mechanically pressurized handguns.

The impacts of these potential mitigations are described below.

- REIs longer than four days in sweet corn may cause growers to switch from mancozeb to another less efficacious fungicide without this restriction, especially during periods when corn fields need scouting twice a week for insect pests.
- The cost of an APF10 respirator and the associated fit test cost may have an economic impact on growers that do not already use this type of respirator. The double layer

clothing requirement could result in heat stress during times of high temperatures and/or humidity, effecting the applicators health and prolonging the time needed for applications.

- Requiring a closed loading system will increase packaging costs and may also require that applicators utilize equipment that can agitate/ mix while the system is closed. Costs of mancozeb use will therefore increase if this requirement were to apply. While growers could opt to switch to utilizing a liquid formulation, it is currently nearly double the cost of the DF formulation.
- Loss of handheld application equipment is not likely to affect mancozeb use in field crops, including field grown ginseng, but could likely hinder fungal control for ginseng growers that produce wild simulated, or wood grown ginseng that may depend on this equipment for use in woody areas.

Additionally, EPA has identified bystander and ecological risks of concern from use of mancozeb in ginseng and field crops. To reduce these risks, the Agency may consider mitigation designed to lessen the likelihood of pesticide drift, this mitigation could include restrictions on windspeed, droplet size, applications during wet weather, application buffers, and groundboom spray release height. Mitigation to reduce bystander exposure, as described above, is considered sufficient to address most ecological risks. However additional mitigation may be needed to further reduce ecological risks, including the addition of a buffer requirement to protect water bodies and mandatory use of Bulletins Live! Two to protect non-target species.

The impacts of these potential mitigations are described below.

- Restrictions that require a medium to courser droplet size, disallowance of applications during periods of rain, and a 3-foot groundboom spray release height are seen as best production practices for these crop sites, so there should be little to no impact to growers that use mancozeb in ginseng and field crop production as described in this memo.
- A 10-mph wind speed maximum may prevent the timely application of mancozeb, potentially resulting in impacts to growers if alternative fungicides cannot be used to effectively manage diseases in these crops.
- A requirement for an application buffer to protect aquatic habitats may require that growers treat the buffer portion of the field with an alternative fungicide that does not have this requirement or leave the field untreated. In either scenario, growers are likely to have costs associated with a second application of an alternative fungicide or suffer yield losses in the untreated buffer area. The overall effect will vary depending on the size of the field affected.
- Requiring that growers obtain and follow additional mitigations in Bulletins Live! Two ahead of pesticide applications is a relatively new process. Therefore, users may face a learning curve when becoming acquainted with the system. Moreover, growers may be subject to additional and potentially more stringent mitigation measures than those described in this memo which can require significant planning and may be costly to implement and maintain.

Also, EPA may require mitigation to reduce run-off that requires growers to adopt one or more strategies from a list of EPA approved strategies.

- These strategies may have an economic impact, dependent on which strategy is adopted, as some measures can be quite costly. However, some growers may already be employing one or more strategy to reduce erosion and/or increase water retention.

INTRODUCTION

The Federal Insecticide Fungicide and Rodenticide Act (FIFRA) Section 3(g) mandates that the Environmental Protection Agency (EPA or Agency) 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 considering scientific advancements, changes in policy, and changes in use patterns that may alter the conditions underpinning previous registration decisions. In determining whether adverse effects are unreasonable, FIFRA requires that the Agency consider the risks and benefits of any use of the pesticide.

The Agency has identified human health risks due to occupational (handler and post application) exposure and ecological risks to several taxa (e.g., birds, mammals) associated with use of mancozeb in ginseng and field crops. To address these risks, the Agency may consider mitigations to address human health risks to workers that reenter a field after a mancozeb treatment by increasing the retreatment interval in grain and sweet corn production. Handheld application equipment is also being considered for cancellation. Additional protective measures may require that applicators use an APF10 respirator and double layer clothing when making mancozeb applications.

To address ecological risks, the Agency may consider mitigation such as maximum windspeed restrictions, droplet size restrictions, and maximum boom height allowances to reduce the potential of spray drift. Additional mitigation to protect non-target organisms could include measures to prevent run-off, inclusive of application restrictions of mancozeb use during periods of rain, application buffer requirements, and adoption of an EPA approved land modification strategy specific to runoff/erosion reduction. Users of mancozeb will also be required to use the EPA database, Bulletins Live! Two to check for additional requirements within six months of a mancozeb application, report accidental pollinator takes, and use pollinator best management practices.

The purpose of this memorandum is to present information on the use and usage of mancozeb, to assess the benefits of the use of mancozeb, and to assess the potential impacts from mitigation on producers who regularly use mancozeb to prevent diseases in ginseng and registered field crops.

This memo considers foliar uses of mancozeb. In separate memorandums, BEAD also assessed the usage and benefits of mancozeb on other agricultural and non-agricultural crops, including seed treatment uses. These memorandums are available in the mancozeb docket (EPA-HQ-OPP-2015-0291) at www.regulations.gov.

METHODOLOGY

This document assesses the benefits of mancozeb use and the impacts of potential mitigation measures to growers of ginseng and field crops. The benefits of mancozeb to the user, in these crops, are based on various agronomic factors, chemical characteristics of mancozeb, and alternative control strategies, which influence how a grower chooses to manage pests and to what extent mancozeb is important to the user. The unit of analysis is an acre of a particular crop that would normally be treated with mancozeb. BEAD assesses benefits at this unit of analysis both because crop growers make pest control decisions at the acre- or field-level, and because risks are usually measured at the same spatial levels (treated acres and treated fields).

BEAD first evaluates mancozeb usage data to identify use patterns such as average application rate, frequency of application, and methods of application. BEAD reviews this usage data and the existing scientific publications to identify the important target pests and the attributes of mancozeb that make it useful in the pest control system. Together, this information establishes where, when, and how growers of ginseng, potatoes, sugarbeets, and sweet corn use mancozeb.

BEAD then evaluates the magnitude of benefits by assessing the biological and economic impacts that ginseng and field crop growers might experience should they need to employ alternative pest control strategies in the absence of mancozeb. BEAD identifies the likely alternative control strategies by reviewing extension recommendations and grower surveys of usage, and consideration of economic factors. Potential impacts to a grower using the next best alternative to mancozeb could include monetary costs (e.g., from using more expensive chemicals) as well as loss of utility in resistance management, simplicity of use, flexibility, and/or integrated pest management programs. There may also be impacts with respect to crop yield loss and/or crop quality reductions related to diminished pest control. This evaluation of the benefits of mancozeb will also be used when considering the potential impacts of possible mitigations to reduce risks from its use in ginseng and field crops. BEAD considers how additional restrictions (e.g., increased reentry intervals) would affect the ability of users to control mancozeb target pests.

For these analyses, data are sourced from university extension services, United States Department of Agriculture (USDA) (e.g., publicly available crop production, pesticide usage, and cost data as well as information submitted directly to EPA), public and commercially available grower survey data, public comments submitted to the Agency from various stakeholders, and BEAD’s professional knowledge. The most heavily used source of data from grower surveys of pesticide usage are purchased from Kynetec USA Inc, a private research firm, which provides pesticide usage data on approximately 60 crops collected annually through grower surveys using a statistically valid approach.

CHEMICAL CHARACTERISITICS

Mancozeb is an ethylene bisdithiocarbamate broad spectrum multisite protectant fungicide in the Fungicide Resistance Action Committee (FRAC) group M03 (FRAC, 2024). Mancozeb is a complex of two other dithiocarbamate fungicides, maneb and zineb, neither of which are registered outside of their combined molecule mancozeb. Mancozeb, as a multisite fungicide, works by deactivating multiple essential enzymes and amino acids in the cells of target pathogens. Due to these multiple pathways for inhibiting disease development, mancozeb, like other multisite fungicides, has a very low risk of resistance development (FRAC, 2010; FRAC, 2018). Multisite fungicides, including mancozeb, typically have a broad spectrum of activity, and mancozeb’s broad spectrum of activity prevents diseases caused by bacteria, fungi, and oomycetes on seed and in the field.

USE AND USAGE

Use

Mancozeb is registered for use on a variety of agricultural crops. Mancozeb is registered for use on ginseng and the following field crops: barley, corn (field, popcorn, and sweet), oats, peanuts, potatoes, rye, sugarbeets, tobacco, triticale, and wheat. Mancozeb is also registered for use on the following field crops grown for seed: sugarbeets, field corn (for hybrid seed), and sweet corn (including for hybrid seed).

Mancozeb formulations for use on ginseng and field crop use sites include dry flowables (water dispersible granules), flowable concentrates (liquid), and wettable powders. These products can be applied via broadcast applications, using ground and aerial equipment.

Usage of Mancozeb in Ginseng

Ginseng is not currently surveyed for fungicide usage at a nationally representative level. Therefore, no sources of usage data are available upon which to make reliable and quantifiable estimates. The absence of such data should not be interpreted as lack of usage.

Usage of Mancozeb in Field Crops

Mancozeb usage on all field crop sites with nationally representative survey data are summarized in Table 1. The usage values presented in this section are annual averages of foliar application uses of mancozeb and are based on the most recent five-year data available from usage data sources. The values presented in this document may differ from those presented in other BEAD documents, such as the Screening Level Usage Analysis (SLUA) or the Summary Use and Usage Matrix (SUUM), because different timeframes are represented in those documents.

Nationally, surveyed field crop growers reported applying approximately 2.5 million pounds of mancozeb active ingredient (lbs AI) to 1.8 million total acres treated (TAT) annually from 2017 to 2021 (Kynetec, 2022a, Kynetec, 2022b). Some crops, such as oats and rye, are not surveyed at a nationally representative level and are not included in this estimate; therefore, these national usage values may underestimate total national mancozeb usage across all registered field crops. Seed treatment usage of mancozeb on field crops may be found in the seed treatment memorandum listed in the introduction.

Table 1: National Average Annual Mancozeb Foliar Usage in Surveyed Field Crops, 2017-2021

Crop	Percent of Crop Treated[1]	Total Acres Treated[2]	Pounds (lbs) AI Applied	Single Application Rate (lbs AI/acre)	Average Number of Applications
Potatoes	40	930,000	1,200,000	1.3	2.4
Sugarbeets	32	770,000	1,100,000	1.5	2.2
Sweet Corn	7	110,000	130,000	1.1	3.6
Tobacco	2	5,300	7,300	1.4	1.3
Peanuts	<1	4,600	2,200	0.5	1.3
Wheat, Spring	<1	21,000	34,000	1.6	1.0
Corn, Field	<1	2,400	2,900	1.2	1.0
Wheat, Winter	<1	1,300	2,100	1.6	2.0

Sources: Kynetec 2022a, Kynetec 2022b

[1] Percent Crop Treated is defined as Base Acres Treated, *i.e.*, the number of acres treated at least once, divided by the number of crop acres grown.

[2] Total Acres Treated is defined as the number of acres treated, which may include counts of multiple treatments to the same field.

Among surveyed field crops, a few had a substantial percentage of crop acreage treated with mancozeb (*i.e*., percent crop treated [PCT]). As shown in Table 1, in terms of PCT, potatoes (40 PCT), sugarbeets (32 PCT), and sweet corn (7 pct) reported the highest usage. Further details on reported usage for these three crops with high mancozeb usage are discussed below.

Many surveyed field crops registered for mancozeb foliar use, such as tobacco, peanuts, wheat, and field corn, report low levels of usage (Table 1). Additionally, no mancozeb usage was reported in a 2019 survey of barley growers (USDA NASS, 2023a). There are no recent available nationally representative usage data for oats, popcorn, rye, and triticale. The absence of such data for oats, popcorn, rye, and triticale should not be interpreted as lack of usage.

<u>Potato</u>

Among all registered field crops, potato growers reported the highest foliar usage of mancozeb in terms of PCT, total acres treated, and pounds of mancozeb applied. Mancozeb usage was reported in every state surveyed for fungicide usage in potatoes, indicating that mancozeb is used by potato growers nation-wide (Kynetec 2022b).

States in the Northwest (Idaho, Montana, Oregon, and Washington) reported a high number of potato acres treated with mancozeb, and growers in these states reported using an average of

1-2 applications per year (Kynetec 2022a). Growers in surveyed states in the Upper mid-west (Michigan, Minnesota, North Dakota, and Wisconsin), Northeast (New York and Maine) and Southeast (Florida) reported higher average number of applications, between 3-4 each year (Kynetec 2022a).

Sugarbeets

On average, over 770,000 acres of sugarbeets were treated nationally with mancozeb each year between 2017-2021 (Table 1). Almost all of this nationally reported usage was located in the Upper Midwest with a high percent crop treated for sugarbeet grown in this region (Minnesota 47 PCT, Michigan 54 PCT, and North Dakota 33 PCT). Low levels of mancozeb usage were reported on sugarbeets within other surveyed areas (Colorado, Idaho, Montana, and Nebraska) (Kynetec 2022a).

Sweet Corn

Nationally, between 2017-2021, sweet corn growers reported mancozeb usage on 7% of the crop area grown (Table 1). Usage was spatially patchy with most of the national-level usage reported in just two states: New York (17 PCT) and Florida (61 PCT). The vast majority of mancozeb usage reported was in Florida, representing 90% of the nationally reported total acres treated. Growers in Florida reported using, on average, over four applications of mancozeb per year, the highest among surveyed states (Kynetec 2022a). All other states surveyed for sweet corn reported little to no mancozeb usage (California, Georgia, Illinois, Minnesota, Ohio, Washington, and Wisconsin).

SCOPE OF ASSESSMENT

Usage data presented above suggests that foliar use of mancozeb may not be of significant importance in many of the field crops where mancozeb is registered. Minimal reported usage, particularly low PCT, suggests that either pathogens controlled by mancozeb are not problematic or that growers have other cost-effective methods to prevent and control those pathogens. Therefore, BEAD concludes that the benefits of the use of mancozeb are low in barley, field corn, peanuts, tobacco, and wheat.

High reported national or regional usage on several registered field crops as presented above (and in Table 1) suggests that mancozeb may be an important tool for growers in those production systems. The highest usage in terms of PCT is seen in potato, sugarbeet, and sweet corn. To determine the potential magnitude of benefits in these crops, BEAD provides a more detailed assessment of the benefits of mancozeb use in potato, sugarbeet, and sweet corn in the next sections of this document.

Other field crops registered for mancozeb use but not surveyed for usage data or identified as an important use site in public comments (*i.e*., following the publication of the drinking water assessment) (*i.e*., oat, popcorn, rye, and triticale) and are not further assessed in this memorandum. BEAD concludes that mancozeb likely has low benefit in these sites due to the overall low usage in similar grain crops (*i.e*., barley and wheat) indicating that mancozeb is not frequently necessary in these production systems. However, this conclusion is uncertain due to lack of data and BEAD welcomes public comments (*i.e*., following publication of the preliminary interim decision) identifying critical uses of mancozeb in any field crops.

Comments from ginseng growers and the USDA Office of Pest Management Policy (OPMP) on the public docket for mancozeb, as well as other registered multisite fungicides, indicate that ginseng growers regularly use mancozeb. This memorandum will assess the magnitude of potential benefits of mancozeb in ginseng production.

BENEFITS OF FOLIAR APPLIED MANCOZEB USE IN GINSENG, POTATO, SUGARBEET, AND SWEET CORN

GINSENG

Nationally, less than 1,000 acres of ginseng are harvested annually, with about 90% of production occurring in Wisconsin (USDA NASS, 2022). Most ginseng production (86% of acres harvested) is used for processing and the remaining 14% of production is used for fresh market sales (USDA NASS, 2022). The root of ginseng is the agriculturally important part of the plant, and the root requires three to five years of growth before harvest (Harrison *et. al*., 2024). Both the foliage and root are susceptible to several pathogens including bacterial, fungus, and nematodes, but the greatest reported challenge in ginseng production is the control of fungal pathogens (Shin *et al*, 2017; Kuack and Heiss, 2022).

Hausbeck (2017; 2019) reports that Alternaria leaf and stem blight, caused by the fungal pathogen *Alternaria panax*, is the most serious pest in ginseng. The disease attacks the foliage when the weather is hot with high humidity, causing leaf damping off which reduces the plant's photosynthetic ability to feed the root, resulting in smaller roots and less yield. When left uncontrolled, *A. panax* can result in an epidemic capable of killing 50 -100% of all ginseng in a field (Hausbeck, 2017).

Control of Alternaria leaf and stem blight is accomplished using both multi- and single site fungicides. Hausbeck (2017) reports that fungicide applications in ginseng begin in early May to June and are repeated every five to ten days until mid-September, potentially resulting in 12-20 fungicidal applications per year. The numerous and frequent fungicidal applications over a multi-year production cycle make risk of resistance development an essential component in considering choice of fungicide and application schedule. Resistance has been documented to multiple highly used chemistries (*e.g*., iprodione and boscalid) (Hausbeck, 2017). Currently, 12 applications of mancozeb are allowed on ginseng per year. Growers reported in public comment that, given mancozeb's low risk to resistance development and effectiveness in controlling Alternaria, some users may be applying the maximum allowable number of annual applications (Ginseng Board of Wisconsin, 2021).

Mancozeb, chlorothalonil, copper, and captan are the four multisite fungicides registered for use in ginseng. Mancozeb and chlorothalonil are recommended for use against Alternaria and are rated as having fair to good and good efficacy, respectively (Hausbeck, 2017). Copper products are reported to have limited efficacy (poor to fair) against Alternaria. Also, copper results in phytotoxicity if used in hot and humid weather, which is the environmental conditions preferred by Alternaria leaf and stem blight. Though captan is recommended in ginseng for other fungal diseases, it is not recommended for Alternaria (Hausbeck, 2017). Therefore, BEAD does not consider either copper or captan replacements for mancozeb for Alternaria leaf and stem blight in ginseng, leaving only mancozeb and chlorothalonil as multisite chemistries to use in rotation with single site fungicides.

Hausbeck (2017) recommends several single site fungicides with good efficacy against Alternaria leaf and stem blight. Fluazinam and the combination fludioxonil + cyprodinil are recommended, but are not popular because of their high cost (Hausbeck, 2017). Azoxystrobin, trifloxystrobin, and pyraclostrobin are currently used by growers; however, early resistance to azoxystrobin has been documented (Ginseng Board of Wisconsin, 2021). Given the high risk of resistance development in many of the recommended single site chemistries, these fungicides are recommended to be used in combination or alternating rotation with mancozeb or chlorothalonil. Thus, growers could apply a multisite fungicide tank mixed with or followed by a single site fungicide, repeating the rotation throughout the growing season when fungicides are needed (Hausbeck, 2017). Therefore, for effective resistance control, a minimum of 6-10 multisite applications would be needed for season-long control.

In the absence of mancozeb, growers would most likely increase their use of chlorothalonil to continue the fungicide rotation as described above. Under current registrations, chlorothalonil labels allow eight applications per year (14 applications in non-harvest years in Wisconsin and Michigan on Section 24c labels) and growers would likely have sufficient control throughout the growing season. However, EPA recently proposed to reduce chlorothalonil's maximum annual application rate. This type of restriction, if realized, would functionally mean that for a particular single application rate, fewer applications of chlorothalonil could be made per year. In some locations, the proposed chlorothalonil mitigations could limit ginseng growers to just four applications a year. In such a case, if mancozeb was not available, growers would not have enough available applications of a multisite fungicide to rotate with single site fungicides for adequate control over the long growing season. Growers would likely need to use lower efficacy and/or higher cost single site fungicides. This would also intensify resistance pressure on the single site fungicides, increasing the likelihood of control failure resulting in yield or quality losses. For these reasons, BEAD considers mancozeb to have high benefits in ginseng production.

POTATO

In terms of acres harvested of potatoes, about 50% of potato production occurs in the Northwest (*i.e*., Idaho, Montana, Oregon, and Washington) and 23% in the Upper Midwest (*i.e*., Illinois, Minnesota, Michigan, North Dakota, and Wisconsin) (USDA NASS, 2022). Between 2017-2021, about 40% of all potato acres nationally received foliar mancozeb treatments (Table 1).

Potato growers reported using mancozeb to control potato blights (Kynetec 2022a). Two types of blight account for most of the fungicidal usage in terms of treated acres in potato production: early blight caused by *Alternaria solani* and late blight caused by the *Phytophthora infestans* (Kynetec 2022a). Early blight is a fungal disease typically found at warmer temperatures than late blight, an oomycete disease, which favors cooler temperatures. (Robinson *et al*., 2022). Early and late are terms used to indicate the relative occurrence of the two diseases in the field, though both diseases can also occur at the same time (Mecure, 1998).

Early blight is a common disease in potatoes that affects the leaves, stems, and tubers. The fungus can reduce yield and tuber size as well as the marketability of fresh market potatoes (Bauske et al, 2018). Late blight is the most damaging disease in potatoes and can destroy entire crops, resulting in 100% yield loss if not managed (Knuteson *et al*., 2022; Sterman Masser, Inc., 2023; WA State Potato Commission, 2023). Plants can collapse and die from late blight in as little as seven to ten days if weather conditions favor the disease (Knuteson *et al*., 2022). Tubers infected with both early and late blight are subject to storage rot (Knuteson *et al*., 2022; Bauske et al., 2018). For blight control, Bohl *et al*. (2003) reports that fungicides may need to be applied every five days when pest pressure is high. Robinson *et al*. (2022) suggests that fungicides will need to be used on a regular and continuous basis for the remainder of the growing season when environmental conditions favor blight.

In public comment, the National Potato Council provided examples of typical fungicide application schedules for several locations around the county (NPC, 2021). In these schedules, protectant multisite fungicides (such as mancozeb) are applied independently and as tank mix partners with single sites fungicides to lower risk of resistance development (NPC, 2021). The number of typical multisite fungicide applications needed for a growing season varied by location but was reported to be as high as 12 applications. Up to 16 applications of a multisite were suggested in a year with a high risk for late blight development (NPC, 2021).

Table 2 below gives the average total acres treated and cost for some fungicides used for early and late blight control in potatoes. The table is broken down into two categories: multisite and single site modes of action. Though mancozeb, chlorothalonil, and copper (*i.e*., multisite fungicides) have reported usage for both early and late blight control (Table 2), only mancozeb and chlorothalonil are recommended by extension as control tools (Nunez and Aegerter, 2019). Copper fungicides are reported to be ineffective for potato disease management under high disease pressure (Johnson *et al*., no date; Friskop *et al*., 2022) and the University of Maine's guide rates copper as "poor" for late blight and does not recommend copper for early blight (Johnson, 2019). Considering that copper is not a recommended control option for potato blights, growers may be using it during times of low disease pressure, especially in light of its reduced cost compared to mancozeb and chlorothalonil. Though sulfur is registered for use in potatoes, sulfur was not commonly applied to potatoes (<1 PCT) and was rarely used to target potato blight diseases (Kynetec 2022a, Kynetec 2022b). In addition, the sulfur labels do not list early and late blight as target pests, and extension recommendations do not include sulfur for early and late blight control. Thus, sulfur is not considered a rotational partner to mancozeb for blight control in potato and would most likely not be used in the absence of mancozeb for these pests.

Though both early and late blight can be in the field at the same time, the single site fungicides recommended are somewhat different for the two diseases. There are several single site fungicides recommended for early blight control including pyraclostrobin, azoxystrobin, boscalid, famoxadone, fenamidone, difenoconazole, fluopyram, penthiopyrad, and pyrimethanil (Wharton and Wood, 2013). Single site fungicides recommended for late blight control include oxathiapiprolin, propamocarb, cyazofamid, cymoxanil, and fluazinam (Table 2). In addition, there are several products that contain two or more single site fungicides for both early and late blight control (Phillips *et al*., 2024).

Table 2. Total Acres Treated and Cost for Recommended Fungicides for Control of Early Blight and Late Blight in Potatoes, National Averages 2017-2021

Active Ingredient	FRAC Group Number	Potato Pest(s) Controlled	Average Total Acres Treated (acres) [1]	AI Avg. Cost/ Total Area ($/acre)
Multisite Fungicides				
Chlorothalonil	M05	Early and Late Blights	1,500,000	$6
Mancozeb	M03		760,000	$6
Copper Hydroxide	M01		250,000	$2
Copper Oxychloride	M01		230,000	$5
Single Site Fungicides				
Pyraclostrobin	11	Early and Late Blights	170,000	$14
Azoxystrobin	11		150,000	$12
Difenoconazole	3		160,000	$6
Fluopyram	3	Early Blight	230,000	$19
Pyrimethanil	9		220,000	$11
Boscalid	7		120,000	$22
Famoxadone	11		110,000	$10
Penthiopyrad	7		50,000	$31
Fenamidone	11		5,000	$26
Cymoxanil	27	Late Blight	150,000	$7
Fluazinam	29		96,000	$18
Propamocarb	28		26,000	$10
Cyazofamid	21		18,000	$15
Oxathiapiprolin	49		14,000	$24

Source: Kynetec 2022a

[1] Total Acres Treated is defined as the number of acres treated, accounting for multiple treatments to the same field.

If unable to use mancozeb, potato growers would most likely increase use of chlorothalonil; both fungicides are broadly recommended for control of early blight and late blight and are effective broad-spectrum tank mix partners for the resistance-prone single site fungicides (Friskop *et al*., 2022; Miller, 2017). Usage data indicates both fungicides are already widely used, and example fungicide application schedules indicate that mancozeb and chlorothalonil are sometimes rotated with one another within the same growing season to cover all needed applications of a multisite fungicide (Kynetec 2022a; NPC, 2021). Under current registrations, chlorothalonil labels allow up to 10 applications per year at the maximum single application rate (14 applications on Section 24c labels in several states). In the absence of mancozeb, growers would likely be able to use chlorothalonil for all necessary multisite applications, unless extreme disease conditions existed.

However, EPA recently proposed to reduce chlorothalonil's maximum annual application rate. This type of restriction, if realized, would functionally mean that for a particular single application rate, fewer applications of chlorothalonil could be made per year. Usage data shows that potato growers in some production regions (Northeast and Upper Midwest) used chlorothalonil more often than proposed annual rate limits would allow (Kynetec, 2022b). In these areas, mancozeb would likely be used to replace applications typically made with chlorothalonil at currently allowed annual rates (Hansel *et. al*., 2024). Given this proposed reduction, if mancozeb was unavailable, chlorothalonil may not be an alternative for growers who need a higher number of multisite applications and are already using the maximum amount of chlorothalonil allowed. In this scenario, growers would have to replace mancozeb applications with single site fungicidal treatments, because copper is reportedly ineffective during heavy infestations. Using single site fungicides without a multisite tank mix partner would greatly increase resistance pressure for these fungicides, possibly resulting in yield loss, while also incurring a higher cost for the use of single site fungicides compared to multisite fungicides (see Table 2).

Mancozeb has high benefits in potato production because of its importance in fungicide resistance management and because it is one of the most efficacious multisite fungicides for early and late blight management. If mancozeb were not available, and considering potential annual rate reductions for chlorothalonil, growers would have to increase their use of single site fungicides at a significant increase in their per acre cost of disease control.

SUGARBEETS

Sugarbeet production occurs in cool northern regions, with approximately 60% of nationally harvested sugarbeet acres located in Minnesota and North Dakota (USDA NASS, 2022). Mancozeb is commonly applied to sugarbeets, with 32% of sugarbeet acreage treated nationally, and an average of 1.1 million pounds applied per year between 2017-2021 (Table 1; Kynetec, 2022a).

About 85% of all fungicidal treatments nationwide in sugarbeets are used to control Cercospora leaf spot caused by the fungus *Cercospora beticola*, and mancozeb is the most used multisite fungicide nationwide (based on TAT) to control this disease (Kynetec, 2022a). Cercospora leaf spot is a common and destructive disease of sugarbeet, and the disease can cause losses in susceptible sugarbeet varieties through reduced yields, reduced sucrose content, and increased impurities (Khan *et al*., 2022). Cercospora leaf spot may be present in the field from canopy closure to late September.

An example of a Cercospora leaf spot management plan (Minn-Dak Farmers Cooperative, 2023a) explains that six applications of fungicides are typically required per year and mancozeb is recommended as a tank mix partner with single site fungicides in three of these applications. The other three recommended applications are copper tank mixed with single site fungicides. These combinations are rotated using mancozeb and copper mixtures with every other application. Minn-Dak Farmers Coop (2023b) report that mancozeb is mostly mixed with specific single site fungicides, either triphenyltin hydroxide (TPTH) or a triazole. This statement is supported by usage data (Kynetec, 2022) showing that TPTH, prothioconazole, mefentrifluconazole, and tetraconazole were the most used single site fungicides for control of this disease, and that mancozeb and copper were highly utilized and applied to a similar number of acres (Table 3).

Table 3 below lists the top fungicides, as ranked by total acres treated (TAT), that are used to treat Cercospora leaf spot in sugarbeets (Kynetec 2022a).

Table 3. Top Fungicides by Total Acres Treated for Targeting Cercospora Leaf Spot in Sugarbeets, National Averages 2017-2021

Active Ingredient	FRAC Group Number	Average Total Acres Treated (Acres) [1]	AI Avg. Cost / Total Area ($/Acre)
Multisite Fungicides			
Mancozeb	M03	420,000	$8
Copper Hydroxide	M01	200,000	$2
Copper Oxychloride		190,000	$8
Single Site Fungicides			
Triphenyltin hydroxide (TPTH)	30	420,000	$5
Prothioconazole	3	260,000	$20
Mefentrifluconazole		68,000	$21
Tetraconazole		67,000	$14

Source: Kynetec 2022a

[1] Total Acres Treated is defined as the number of acres treated, accounting for multiple treatments to the same field.

If mancozeb were not available, sugarbeet growers would most likely increase their use of copper products, thereby using copper mixed with single site fungicides for the entire growing season. Mancozeb is more expensive than copper hydroxide (Table 3); however, mancozeb is also reported to be the more effective tank mix partner for control of Cercospora leaf spot (Minn-Dak Farmers Coop., 2023a; SMBSC, 2003). So, if growers replaced mancozeb with copper, they may experience yield loss. For these reasons, mancozeb is considered to have high benefits in sugarbeet production for Cercospora leaf spot control.

SWEET CORN

Sweet corn is grown throughout the U.S. and mancozeb was used on 7% of all sweet corn nationally with nearly 130,000 pounds applied per year during the period 2017-2021 (Kynetec, 2022b). About 90% of this usage in terms of treated acres and pounds applied occurred in Florida, with 61% of the acreage in Florida receiving at least one application of mancozeb. Therefore, the assessment of mancozeb benefits in sweet corn will focus on Florida production.

In recent years (2017-2021), mancozeb was the top fungicide applied to Florida sweet corn in terms of total acres treated and PCT (Kynetec, 2022b). Florida sweet corn growers reported using on average over four applications of mancozeb per year (Kynetec, 2022a). The majority of mancozeb applied in Florida is to treat leaf blights (Kynetec, 2022a) caused by the fungal pathogens *Bipolaris maydis* that results in Southern corn leaf blight and *Exserohilum turcicum* that causes Northern corn leaf blight (Kucharek and Raid, 2000). Both leaf blights grow quickly in similar conditions of relatively cool temperatures (64-84 °F) with either wet or high-humidity environments (Dufault, 2023). Leaf blights cause destruction of the leaves that results in less leaf area for photosynthesis. Most diseases in sweet corn, including leaf blights, are controlled by using resistant hybrids (Kucharek and Raid, 2000).

Table 4 below lists all fungicides recommended for leaf blights (Raid, 2020; Crop Protection Network, 2011). Only a few have reported usage for targeting leaf blights in Florida sweet corn (Kynetec 2022a). Mancozeb and chlorothalonil are the only multisite fungicides recommended for control of these diseases (Raid, 2020). Sulfur and copper are also registered for use in sweet corn, but neither chemistry has reported usage for controlling this disease during the last five years of data (Kynetec, 2022a). Therefore, neither sulfur nor copper are considered an alternative to mancozeb.

Table 4. Recommended Fungicides by Total Acres Treated Used for Targeting Leaf Blight* in Sweet Corn, Florida Annual Average 2017-2021

Active Ingredient	FRAC Group Number	Average Total Acres Treated (Acres) [1]	AI Avg. Cost / Total Area (US$/Acre)
Multisite Fungicides			
Mancozeb	M03	51,000	$6
Chlorothalonil	M05	13,000	$7
Single Site Fungicides			
Metconazole	3	14,000	$8
Propiconazole		13,000	$3
Tebuconazole		no reports	no reports
Prothioconazole		no reports	no reports
Penthiopyrad	7	no reports	no reports
Benzovindiflupyr		no reports	no reports
Fluxapyroxad		no reports	no reports
Pydiflumetofen		no reports	no reports

Active Ingredient	FRAC Group Number	Average Total Acres Treated (Acres) [1]	AI Avg. Cost / Total Area (US$/Acre)
Pyraclostrobin	11	15,000	$10
Azoxystrobin		3,000	$6
Picoxystrobin		no reports	no reports
Trifloxystrobin		no reports	no reports
Fluoxastrobin		no reports	no reports

Source: Kynetec 2022a
[*]Leaf Blight = "unspecified" Leaf Blight, Northern Corn Leaf Blight, or Southern Corn Leaf Blight
[1] Total Acres Treated is defined as the number of acres treated, accounting for multiple treatments to the same field.

The University of Florida (2023) reports that mancozeb is an important chemistry in resistance management programs and as a tank mix partner with single site fungicides. The recommended single site fungicides for blight control are limited to three different fungicidal classes (*i.e*., Groups 3, 7, and 11) which puts these fungicides at a greater risk of resistance than would be likely if additional rotational partners with additional group numbers were available.

Without mancozeb, growers would be dependent on only chlorothalonil as a multisite rotational and tank mix partner with these single site fungicides. However, the Agency is considering reducing the maximum annual application rate for chlorothalonil, which may greatly reduce the number of chlorothalonil applications that can be used in sweet corn per year. In some locations, the proposed chlorothalonil mitigations could limit sweet corn growers to just four applications a year. Given this proposal, in the absence of mancozeb, it is possible that a sufficient number of applications of chlorothalonil would not be available to growers that need more than four applications of a multisite fungicide in a growing season. In such a case, growers would have to depend on use of single site fungicides alone or with other single site tank mix partners which may increase the cost of control and risk of resistance development in leaf blight.

Mancozeb is important in Florida sweet corn production for its role in resistance management and because it is the most used multisite fungicides for control of corn leaf blights. Without mancozeb, growers would be left with only chlorothalonil to use in single site fungicidal mixtures, which may not be as effective as mancozeb leading to compromised control and yield losses. Also, mancozeb may gain greater importance if the maximum annual application rate of chlorothalonil is reduced in EPA's registration review process. Therefore, although mancozeb likely has low benefits in sweet corn production on a national basis, it has high benefits in Florida production.

IMPACTS OF POTENTIAL MITIGATION

EPA has identified human health and ecological risks of concern from use of mancozeb in field crops. To reduce the risks to occupational users of mancozeb in field crops, EPA is considering risk mitigation measures such as increasing the restricted entry intervals (REI), increasing the level of personal protective equipment (PPE), disallowing use of some handheld equipment, and requiring a closed loading systems for certain application methods and formulations. To reduce the risks to human bystanders and ecological taxa, the Agency is considering mitigation to reduce spray drift, prevent runoff/erosion, and implementation of *Bulletins Live! Two* before a pesticide application. Details regarding the impacts of these potential risk mitigation measures are discussed below.

Mitigations to Address Risks to Human Health

To reduce human health risks resulting from field crop applications, the Agency is considering the following risk mitigation measures:

- Increasing the restricted entry interval (REI) in sweet corn from the current 24-hours to 10-days for workers entering a treated field following a mancozeb application.
- Requiring an Assigned Protection Factor 10 (APF10) respirator, use of double layer clothing, and use of chemical resistant gloves during mancozeb applications.
- Requiring a closed loading system for mixer/loaders when utilizing dry flowable and wettable powder formulations for aerial and chemigation applications.
- Disallowing the use of mechanically pressurized handguns and backpack sprayers in all cropping systems.

Increase in Restricted Entry Intervals

To reduce risks to occupational handlers from foliar applications of mancozeb, EPA is considering increasing the current 24-hour REI in sweet corn to ten days. BEAD evaluated the impact of a longer REI in sweet corn by considering other production activities that may be complicated or impeded by an increased REI. A 10-day REI would prohibit field scouting for other sweet corn pests (*e.g.*, insects and weeds) within ten days of application. As was shown in Table 1 above, sweet corn is treated about 3.6 times with mancozeb annually, so this mitigation option would be impactful multiple times in a year. Two of the most economically important insects that infest sweet corn during the same periods that mancozeb is being used to treat diseases (Kynetec 2022a) are the fall armyworm (*Spodoptera frugiperda*) and the corn ear worm (*Heliocoverpa zea*) (Nuessly and Webb, 2003; Gianessi and Willians, 2011; Mossler *et al*., 2014). Aerts and Mossler (2007) report that both pests require scouting twice a week, or every 2 to 4 days to avoid economic damage. Thus, growers might be able to continue using mancozeb with a three-to-four-day REI without impeding other pest control.

If growers were unable to accommodate a 10-day REI they would likely switch from mancozeb to another fungicide that has a shorter REI but could potentially result in reduced pest management and/or suffer yield loss.

Additional Personal Protective Equipment – APF10 Respirator and Double Layer Gloves

Requiring double-layer coveralls and gloves for mancozeb mixers, loaders and applicators is not anticipated to have a great impact on users of mancozeb. However, the use of a PPE (e.g., wearing double layers or respirator when applying pesticides) can reduce productivity of workers because of the physiological stress when working in high temperatures and/or humid conditions (O'Brien et al., 2011). Workers may need to take more frequent breaks in certain situations than if extra PPE were not required. Individuals will respond differently depending on many factors, such as fitness level, hydration, acclimatization, etc. More frequent breaks could decrease productivity, which will increase the time required for an application to be made, and likely increase costs.

Requiring use of a APF10 respirator may impose a cost on users for the respirator and fit test unless they already use a respirator for other chemicals. Respirator costs are extremely variable depending upon the protection level desired, disposability, comfort, and the kinds of vapors and particulates being filtered. APF10 or Assigned Protection Factor 10 (APF10) respirators include N95 masks, which are readily available. Under the Worker Protection Standard, users of respirators are required to have a fit test done annually. BEAD found the cost of a respirator fit test to be about $350 per applicator per year; this includes materials and the time required to obtain the test (Smearman and Berwald, 2024) as well as for health screening. Alternatively, growers could hire a commercial applicator or use an alternative that does not require a respirator (chlorothalonil and copper labels do not require the use of a respirator).

Closed loading for Mixers and Loaders Utilizing Certain Mancozeb Formulations

The Agency is considering requiring that a closed pesticide delivery system be used for mixing and loading when preparing dry flowable (DF) and wettable powder (WP) formulations of mancozeb. This requirement may only be required for growers preparing for aerial or chemigation applications because these are the only application methods for which risks were identified. Most applications of mancozeb in sugarbeet, potato and sweet corn were made using DF and WP formulations. For potato and sugarbeet, however, most applications were made via groundboom and therefore most growers of these crops would be relatively unaffected if only aerial and chemigation methods need a closed system. In sweet corn, however, almost as many mancozeb acres are treated aerially as with groundboom. These growers that rely on aerial applications would be affected by the closed pesticide delivery system requirement (Kynetec, 2022a).

A closed pesticide delivery system for these formulations may entail that the pesticide be enclosed in a water-soluble packet that can then be inserted into water within the pesticide delivery system. Then the container is closed to protect the worker as the packet and pesticide dissolves in water. This requirement means the product cost is likely to increase due to packaging costs and these costs may be passed to growers. Additionally, packages mean that the pesticide would be sold in discrete amounts and therefore could further lead to increased costs and increased complications of disposing of excess pesticide. Moreover, agitation equipment may also be required to ensure the product mixes in water uniformly but does not expose the mixer/loader. Alternatively, growers could use the liquid formulation of mancozeb for the crops assessed in this memo, but this formulation is more costly compared to the most the DF formulation (Kynetec, 2022a). If the costs of utilizing the DF increase and outweigh the cost of utilizing the liquid formulation, applicators may opt to use the liquid formulation. In either scenario, growers are anticipated to bear an increased cost of use of mancozeb.

Disallowing Use of Mechanically Pressurized Handguns

Use of handheld equipment is typically reserved for spot treatments, but because mancozeb applications are intended to prevent fungus infections before they occur, BEAD expects the entirety of a large field (i.e., potatoes, sugarbeets, and sweet corn) would receive a mancozeb application all at once, most likely with aerial or groundboom equipment. While ginseng acreage is much smaller, typically about 10 acres or less per farm (Santiago *et al.,* 2021), the premise of preventive sprays covering one continuous plot of land still holds true, so groundboom is still the most likely application method in field grown ginseng. However, there may be occasions when a handgun may be needed, such as in wild-simulated or wood grown ginseng production. These ginseng plots are grown in forested areas which would be difficult to reach with ground equipment, and plots may be separated by other vegetation (Kaiser and Ernst, 2016; Vaughan *et al*., 2011; USDA Forest Service; 1999). In such a case, handguns may be necessary.

Thus, for most field grown crops, including field grown ginseng, the impact of prohibiting handheld equipment is likely low. However, handguns and backpack sprayers may be important and necessary for a small subsection of ginseng growers that produce wild simulated, or wood grown ginseng. If these ginseng growers were unable to use mancozeb because of the proposed prohibition on applications via handguns or backpack equipment, then these growers could see reductions in disease control, resulting in yield or quality losses, and/or an increase in fungicide resistance due to a lack of a sufficient number of efficacious, multisite alternatives to manage key pests in ginseng production, like Alternaria leaf and stem blight.

<u>Impacts of Potential Ecological Mitigation</u>

EPA is considering mitigation measures to reduce spray drift. One mitigation measure being considered is changing the required droplet size from fine or courser to requiring medium or coarser droplet sizes for aerial applications and retaining the labeled droplet size of medium or coarser for groundboom applications. Additionally, EPA is considering changing prohibition of application when windspeeds are above 15 miles per hour (mph) to a prohibition of applications when windspeeds are above 10 mph for both aerial and groundboom applications. EPA is also considering increasing the required release height for aerial applications from 3 ft to 10 ft for aerial applications and 3 ft above the crop canopy for groundboom applications. EPA is considering a 50 ft spray drift buffer for aerial applications and a 10 to 15 ft buffer for groundboom applications. BEAD expects low to moderate impacts from these potential spray drift mitigation measures to field crop and ginseng producers who use mancozeb as explained in the next two sections.

Droplet Size

Good coverage is important for the efficacy of a protectant fungicide. Medium droplets have shown to deposit efficiently and provide good coverage on stems and narrow vertical leaves, such as grasses, if applied when there is some air movement (Mueller *et al.,* 2021; VCE, 2018). With a medium droplet size requirement growers will still get good coverage, so there should be little impact for this spray drift measure. On the other hand, a potential requirement for coarse or coarser droplets could impact growers because larger droplets hold together rather than spread out over the foliage which could result in poor coverage and a potential reduction in efficacy of a protectant fungicide.

Application Restrictions During or Prior to Rainfall

To reduce the potential for runoff, EPA is considering prohibiting mancozeb applications during or prior to a rainfall event. EPA does not anticipate that a restriction which prohibits mancozeb applications while it is raining will affect applicators. While fungicide applications may be made prior to a rainfall event, applicators would not apply during a rainfall event, as this would not be desirable for the product staying in place and preventing disease.

EPA is also considering mandatory rain event language on labels which would prohibit mancozeb applications when a storm event likely to produce runoff from the treated area is forecasted to occur following an application within 48 hours. A 48-hour restriction on mancozeb applications prior to rain events predicted to be greater than one inch is expected to be highly impactful to applicators of mancozeb as pathogens thrive in periods of wet weather. Coating plants with a protective fungicide such as mancozeb prior to rain events helps to prevent the initiation and spread of disease; for this reason, protectant fungicides are commonly applied before a rainfall event (Egel, 2021). Growers are unlikely to apply mancozeb during or immediately before rainfall as it may get washed away and typically apply up to 24 hours prior to rain depending on rainfastness recommendations. Restricting mancozeb applications 48 hours before a rain event predicted to be greater than one inch would limit applicators' flexibility in using mancozeb to protect crops against fungal diseases during vulnerable wet weather events, which could lead growers to switch to an alternative fungicide without rainfall restrictions and/or result in suboptimal disease control. Impacts may be greater in areas with more frequent rainfall, such as the Southeast.

Shorter rainfall restriction periods, such as a 24-hour restriction, would have lower impacts on application flexibility and disease management.

Spray Release Height

For groundboom applications, choosing the correct spray release height is important to obtain proper coverage. If nozzles are placed too low, the spray pattern may be too narrow, and coverage could be uneven. A grower may have to purchase new nozzles to accommodate a spray height or apply a different chemical that does not have this restriction. However, a review of manufacturer recommendations found that many nozzles and spray equipment require release heights of 2 ft or greater (Tindall and Hanson, 2018), so a 3 ft release height should not be impactful to most growers. For aerial applications, the agency considers this to be standard application practice and does not anticipate any impacts from the requirement for a 10 ft release height.

Windspeed Restrictions

Windspeed restrictions could limit the grower's ability to make time-sensitive applications of mancozeb by reducing the days or hours with allowable conditions. Users would have to adjust their application schedules accordingly and may have to take on additional planning efforts to ensure compliance, which may result in additional costs. If preventative applications cannot made in a timely manner with a multi-site fungicide, then effective disease control could be compromised, which may lead to production loss, or additional curative applications with single site alternative fungicides. Disease prevention and early control are critically important because irreversible damage can occur very quickly if a disease goes uncontrolled. If new, lower windspeed restrictions are put into place, then mancozeb users will have an increase in managerial effort from additional planning efforts to ensure compliance with this restriction. However, it should also be noted that professional applicators and use site managers are expected to plan pesticide applications in advance of use, while taking into consideration contingent weather and environmental conditions as part of their pest management programs.

Spray Drift Buffers

Field Crops - Growers who would be required to implement a buffer have three options, all of which result in the loss of mancozeb as a control method in the buffer area: 1) replace mancozeb with an alternative control method for treatment of the entire field; 2) replace mancozeb with an alternative control method in just the buffer area while treating the interior field with mancozeb; or 3) leave the buffer areas untreated. The impacts of the first two options are equivalent to the loss of mancozeb in the area where mancozeb is not used; depending on the site, pest, and available alternatives, switching to other controls may result in yield or quality losses, or increases in the cost of control. The second option would also necessitate extra trips through the field. Extra trips through a field imposes a burden beyond just the time it takes a grower to make the extra trip – growers must clean equipment before switching to another chemical. Also, environmental factors (wind, rain) and equipment availability, may further limit the feasibility of making separate applications to buffers. Beyond the increased application costs, growers would also incur any impacts from using alternatives, as with the first option. Yield or quality losses would be highly likely if the buffer area is left completely untreated as with the third option, but if the buffer is small, it may be impractical to treat it separately. In some situations, losses may be large enough that it is no longer worth cultivating the buffer and growers remove the land from production.

Spray drift buffers can affect a substantial portion of a field, especially when fields are small. Larger buffers impact a larger proportion of the field than smaller buffers. To characterize the effect that buffers may have on growers, BEAD shows how different sizes of no-spray buffers can impact growers who want to use mancozeb on different sized fields (Table 5). To illustrate the effect of a buffer, consider a rectangular field with a length equal to twice its width, with the buffer on the long side of the field. In this scenario, the field is immediately adjacent to the sensitive area. If the buffer were to fall on the short side, the affected area would be substantially less. Irregularly shaped fields could be affected substantially more. In situations where the field to be treated is not immediately adjacent to the protected area, the part of the field affected by the spray buffers is smaller/narrower than if the field edge is immediately next to the habitat.

Table 5. Percent of Fields* of Various Sizes Lost to In-Field Buffers of Various Sizes.

Field Size (Acres)	1	10	50	100
Buffer Size	Percent of Field Affected by Buffer			
25 Feet	12%	4%	2%	1%
50 Feet	34%	11%	5%	3%
100 Feet	68%	21%	10%	7%

*Calculations based on a rectangular field with length equal to twice its width, with the in-field buffer on the long side of the field.

Larger buffers would be required for aerial applications. For some field crops treated with mancozeb, aerial applications are quite common; arial applications account for 52% of the area treated in potatoes, 15% of the area treated in sugarbeets, and 88% of the treated area of sweet corn (Kynetec 2022a).

As shown in Table 5, a 50-foot buffer results in the loss of 11% of a 10-acre field, but only 3% of a 100-acre field, so field crop growers with smaller fields of these crops could be highly impacted, while growers with larger fields would be less impacted. Similarly, smaller buffers of around 10 to 15 feet would only be very impactful for smaller fields, especially those less than 10 acres. Some growers may be able to switch to groundboom applications with smaller buffers, but others may not be able to switch their application method, and may need to use an alternative fungicide, which may be less efficacious and/or higher in cost per acre.

Ginseng - There are less than 1,000 acres of ginseng grown per year in the U.S. and most farms are less than 10 acres, with only three growers that produce more than 100 acres but less than 300 acres (Santiago *et al.,* 2021). Ginseng production could be impacted if risk mitigation results in large buffers for mancozeb applications, since smaller farms and fields are highly impacted by large buffers. For groundboom applications, a 15-foot buffer may have impacts in ginseng production. As shown in Table 5, a 30-foot buffer results in the loss of 6% of a 10-acre field, and 20% of a 1-acre field, so a 15-foot in-field buffer would result in the loss of roughly 3-10% of acre(s) in production for the majority of ginseng farms.

Aerial buffers should have no impact on ginseng growers, since ginseng is grown under a shaded shelter or under a forest canopy (USDA Forest Service, 1999) which precludes aerial applications. If ginseng growers were unable to use mancozeb because of the proposed buffers, then ginseng growers could see reductions in disease control, resulting in yield or quality losses, and/or increase in fungicide resistance due to a lack of sufficient number of efficacious multisite alternatives to manage key disease pests in ginseng, like Alternaria leaf and stem blight.

<u>Adoption of Mitigation Measure(s) from the Menu of Run-Off Mitigation Options</u>

The Agency is considering the inclusion of a menu of mitigation options to reduce field runoff or erosion of mancozeb treated fields to protect terrestrial/aquatic animals in adjacent waterbodies or specified conservation areas. Mitigation options may include for example, use of a vegetative filter strip, field terracing, or use of a cover crop. EPA may require growers to use one or more mitigation measure(s) on fields receiving applications of mancozeb regardless of production acreage.

A menu of mitigation options offers flexibility to growers to adopt practices that are best suited to their fields rather than requiring that all users of mancozeb to adopt the exact same runoff mitigations. If growers are already using one or more of the practices for erosion control, they may not need to undertake further action. However, several options on the menu of mitigation have substantial burdens associated with implementation. For instance, vegetative filter strips (VFS) take land out of production and are also costly to establish and maintain. The establishment costs for VFS range from $165-$927 per acre of VFS, and maintenance costs range from $40-$240 annually per acre of VFS (USDA OPMP, 2018). Additionally, not all practices are feasible for all fields. For example, terraced fields are not able to be implemented on flat ground. While some of the menu of mitigation practices can be implemented on an annual basis (e.g., cover cropping), other menu of mitigation practices requires significant planning and depending on the option chosen, may require some engineering to implement (e.g., runoff retention pond). Once the growing season has started, none of the practices can be adopted without substantial interruptions to production. Growers may need to adopt runoff/erosion mitigations simply to maintain the option of using mancozeb if the field is infested and will lose some flexibility in changing pest management programs in response to unexpected pest pressures.

Growers who rent or lease land may be constrained in their ability to implement mitigations, especially structural mitigations (*e.g.*, terraces, vegetative filter strips) due to the terms of existing lease agreements. Determining whether the landlord or tenant will bear the costs of implementing mitigations may further complicate the ability of farmers who lease land to implement mitigations. If growers who lease land are unable to implement land modifications for runoff reduction, then those growers may be unable to use mancozeb. In some cases, mancozeb may be the only multisite fungicide available; thus, this mitigation would have high impacts on users of mancozeb.

Mandatory Use of Bulletins Live! Two Labelling

EPA may require that growers obtain and follow Bulletins Live! Two (BLT) ahead of an application of mancozeb. This internet-based system will inform the user of additional label requirements that they need to follow when making an application of mancozeb in their specific geographic area. Because some of the mitigation measures needed to protect threatened and endangered species (referred to as listed species) may be applicable only in particular geographic regions where listed species occur, and/or because listed species may require different mitigations for the of mancozeb to protect them from exposure, a physical label that contains all the mitigation information would be many pages long and difficult to use. The complexity of a paper label would likely be compounded by the future changes to the listed species and their ranges. To simplify this process, EPA will provide information on what mitigations are required for each application site depending on its location in Bulletins Live! Two (BLT). This online tool will assist pesticide users in identifying the mitigations relevant to their situation instead of requiring the user to conduct this effort themselves.

The BLT system has been in place for many years but the requirement to access BLT before using a pesticide is relatively new for many pesticide products. As discussed in the ESA Workplan Update issued by the Agency in November 2022, the requirement to access BLT will eventually apply to most pesticides. Therefore, over time and with wider implementation, BLT will become a tool that growers are familiar with, and consulting BLT ahead of a pesticide application will become routinely integrated into a user's application process. Applicators can check BLT any time between the day of application and up to six months in advance. Some requirements (mitigation measures) may need substantial time (potentially more than six months) and careful planning to implement, as discussed in the previous section related to run-off mitigation options. In other cases, if required mitigation for the Pesticide Use Limitation Area is already in place, applicators may be able to check BLT and make a pesticide application on the same day while meeting the requirements listed on BLT.

A recent USDA NASS (2023b) report on farm computer usage and ownership reported that 85 percent of farms have internet access, and a similar proportion of farms own smart phones and/or computers. However, fewer farms reported using the internet to conduct business. As mentioned earlier, growers not accustomed to accessing BLT or using online tools as a part of their regular farm business could face a learning curve, but with time and as users become acquainted with this system, this burden will diminish.

CONCLUSION

Mancozeb is used in ginseng, and in field crops, particularly potatoes, sugarbeets, and sweet corn to manage important fungal and oomycete diseases. Mancozeb plays an important role in plant disease prevention and resistance management because it has a multisite mode of action; it has a broad-spectrum of pests controlled; and it typically costs less than most alternative single site fungicides. Like other multisite fungicides (*e*.g., copper, chlorothalonil, captan, and sulfur), mancozeb's benefits for resistance management are two-fold, i.e., control of its target pathogens, and a reduction in the rate of resistance development to comparably more effective single site fungicides. These benefits are important in agrosystems where multiple foliar applications with multisite fungicides and different MOAs are necessary throughout the growing season to avoid resistance development in pests.

Due to its efficacy against damaging diseases, role in resistance management, and limited multisite fungicide alternatives, mancozeb has high benefits for control of major fungal pathogens such as Alternaria leaf and stem blight in ginseng, early and late blight in potatoes, Cercospora leaf spot in sugarbeet, and leaf blights in Florida sweet corn. Currently the primary alternative multisite fungicide, chlorothalonil, is available to replace some applications of mancozeb for disease control in ginseng, potatoes, and sweet corn. However, the Agency has recently proposed reduced annual application rates for chlorothalonil in these sites. If chlorothalonil annual rate reductions are implemented, then use of chlorothalonil may not be able to provide growers with enough applications within a year to make up for the loss of mancozeb. Consequently, the benefit of mancozeb may increase in these production systems if the rate reductions are implemented for chlorothalonil.

Other registered field crop sites reported minimal usage of mancozeb. This lack of usage suggests that growers either have other cost-effective tools available to control mancozeb target pests or the pathogens which mancozeb is effective against are not problematic in these use sites. BEAD concludes low benefits in these sites. BEAD additionally concludes likely low benefits for registered field crops not surveyed for usage data or identified as an important use site in public comments (*i.e*., oat, popcorn, rye, and triticale) due to similarities with other small grain crops where mancozeb has low benefits.

EPA has identified human health risks of concern from use of mancozeb in ginseng and field crops. To reduce the human health risks to occupational users of mancozeb in these crops, EPA is considering risk mitigation measures such as increasing the sweet corn reentry interval from the current 24 hours to 10 days; requiring APF10 respirators and double-layer clothing for foliar applications in all crop sites; and removing the use of handguns and backpack sprayers in ginseng and field crops.

Considering the REI increase in sweet corn, under high pathogen and insect pest pressure, an REI of four day or less should not preclude the use of mancozeb in this crop, but a REI longer than four days, may. This mitigation could be highly impactful to sweet corn growers who use mancozeb, especially in Florida.

Respirator costs are extremely variable depending upon the protection level desired, disposability, comfort, and the kinds of vapors and particulates being filtered. BEAD expects the actual cost of purchasing a APF10 respirator, a category which includes N95 respirators, to be a less substantial cost burden than the cost of the annual fit test. EPA estimated the annual fit test to cost about $350 in 2024. In lieu of purchasing a respirator, field crop and ginseng growers could use another fungicide that does not have this requirement if available. Both respirator requirements and double-layer clothing may impact the user in the form of heat stress, requiring additional rest breaks that would result in an increase in the time and labor cost for applying mancozeb. Handgun and backpack applications in field crops are most likely rare, thus, prohibiting the use of mechanically pressurized handgun applications is expected to have little impact on field crop growers who use mancozeb in their crop production. However, the impact may be greater in wild-simulated and wood grown ginseng production because these fields are typically much smaller, and located within forested areas where handheld equipment may be the only available application method.

EPA has also identified ecological risks of concern from use of mancozeb in ginseng and field crops. To reduce the risks to ecological taxa from use of mancozeb in ginseng and field crops, EPA is considering multiple mitigation measures that reduce spray drift, runoff, and/or erosion.

To reduce ecological risks from spray drift, EPA is considering buffer requirements for both groundboom and aerial applications. Buffer restrictions will have a greater impact on farms with smaller fields such as ginseng, where a large portion of the field may be taken out of production. EPA is also considering windspeed restrictions. A 10 mph windspeed restriction is not likely to impact ginseng production because the plants are grown under a shaded covering that naturally reduces wind movement. However, a 10 mph windspeed may be impactful for field crops, particularly when the weather conditions are conducive to pathogen infections that must be treated in a timely fashion to prevent fieldwide infection epidemics. In addition to buffers and windspeed restrictions, EPA is considering requiring medium or coarser droplet size. A medium or coarser droplet size is not expected to have an impact on ginseng or field crop production. With a medium droplet size requirement, field crop growers will still get good coverage, which is important for fungicide application.

To reduce ecological risks from runoff and erosion, EPA is considering restricting applications of mancozeb during rainfall. An application restriction during rain is not expected to have an impact on ginseng or field crop production, since this is considered a best management practice for pesticide applications. To further reduce runoff/erosion, EPA is considering requiring the adoption of an EPA approved runoff mitigation measure from a list of measures. Mitigation to reduce run-off that requires growers to adopt mitigation measure(s) from a list of EPA approved strategies, may have an impact on growers depending on which strategy is adopted. Some growers that already have at least one of the mitigation strategies in place may not need to make any changes.

To reduce additional ecological risks, EPA is considering adding requirements to check Bulletins Live! Two, pollinator incident reporting, and pollinator best management practices. EPA is considering adding a requirement to check Bulletins Live! Two within six months prior to a mancozeb application, this requirement to obtain and reference Bulletins Live! Two may be onerous for some growers that do not have internet access to the online application. However, EPA expects this burden to be substantially lower for most users relative to lengthy paper labels. Growers may be subject to additional and potentially more stringent mitigation measures included in Bulletins Live! Two than those described in this memo, which can require significant planning and may be costly to implement and maintain.

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