OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION
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MEMORANDUM

SUBJECT: Mancozeb (PC 014504) Registration Review: Assessment of Use, Usage, Benefits and Impacts of Potential Mitigation of Foliar Uses in Cucurbits, Peppers, and Tomatoes

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Summary

Mancozeb is a broad-spectrum multisite protectant fungicide (Fungicide Resistance Action Committee [FRAC] group M03) registered for many agricultural and non-agricultural uses. Growers of cucurbits (including cantaloupe, cucumber, pumpkin, squash, watermelon), tomatoes, and peppers apply mancozeb to control fungal and bacterial pests. BEAD finds that mancozeb provides high benefits in cucurbits, tomatoes, and peppers. Mancozeb is primarily used for preventative control of a broad spectrum of pathogens and unlike single site fungicides, it can be applied consecutively and many times over the course of the growing season with little risk of resistance and at a lower cost than many fungicides.

Mancozeb therefore plays a role in season long disease control and resistance management in cucurbits, tomatoes, and peppers. Chlorothalonil is another multisite fungicide also used frequently for disease control. EPA recently proposed to reduce the maximum annual application rate for chlorothalonil, effectively limit the number of applications permitted. BEAD finds that the reductions in available chlorothalonil applications further underscores the importance of the availability of mancozeb in cucurbit crops assessed in this memo. Without mancozeb, and considering the limits on chlorothalonil, growers of cucurbits, tomatoes and peppers in high pest pressure regions would incorporate more single site fungicides into their season-long fungicide rotation, which would result in increased resistance risk which in the future could eventually result in yield and quality losses. Moreover, in tomatoes and peppers, mancozeb combined with copper controls bacterial spot disease and there are no effective alternatives to control this disease in these two crops. Without mancozeb, tomato and pepper growers would incur yield and/or quality losses both in the near and long term.

The EPA has identified risks to occupational handlers (mixers/loaders and applicators), bystander risks, and ecological risks to non-target organisms when mancozeb is applied to cucurbits and in tomatoes and peppers.

The Agency is considering reducing occupational handler worker exposure risks through:

- Requiring use of APF10 respirators and additional personal protection equipment (PPE) for mixers, loaders, and applicators when utilizing any mancozeb formulation. The primary burden is the cost to obtain an annual fit test of the APF10 respirator and the potential for heat stress on workers which can result in more frequent breaks and can increase the time and labor cost of utilizing mancozeb.
- Closed loading system for mixers and loaders when utilizing dry flowable and wettable powder (DF and WP) formulations, which 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. This will increase packaging costs and may also require that applicators utilize equipment that can agitate or 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.

- Prohibiting use of mechanically pressurized handguns. This mitigation is not expected to impact current production practices for cucurbits, tomato, and pepper growers unless there are very small operations that utilize these application tools. These growers may need to acquire small ground boom equipment.

The Agency is considering addressing post-application worker exposure risks through:

- Extending the restricted entry interval by up to three days for cucurbit, pepper, or tomato. A 3-day REI is not anticipated to be highly disruptive or impactful to current production practices in these crops. However, it would require that operators post warning signs, which could be an additional burden in time and labor.

The Agency is considering addressing bystander and ecological risks through:

- Spray drift mitigation (i.e., windspeed restrictions to 10 mph, increased droplet size, and buffers). Windspeed restrictions reduce grower flexibility when making a pesticide application. A medium droplet size is anticipated to be acceptable for growers utilizing mancozeb, but larger droplets could reduce coverage and efficacy. Buffers may mean that growers must treat a portion of the field with different fungicides or leave the area untreated. If growers cannot apply mancozeb in buffer areas, high yield losses are likely in peppers and tomato. In cucurbits, growers may have to utilize multiple single site fungicides, but this is anticipated to increase risks of resistance and ultimately lead to yield and/or quality losses. The overall effect will vary depending on the size of the buffer and the size of the field affected.
- Prohibiting mancozeb applications 48-hours ahead of any projected rain event that is likely to result in runoff. This potential restriction on applications prior to rainfall to be highly impactful to users of mancozeb, which is a preventative fungicide, as periods of wet weather are when plants are most vulnerable to foliar diseases.
- Requiring that growers obtain and follow additional mitigations in Bulletins Live! Two ahead of pesticide application. Even though this web-based system has been in place for many years, the requirement that growers access and follow Bulletins is relatively new. 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.

Introduction

Mancozeb is a broad-spectrum protectant fungicide registered for use on agricultural and non-agricultural sites. 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 in light of scientific advancements, changes in policy, and changes in use patterns that may alter the conditions

underpinning previous registration decisions. In determining whether adverse effects are unreasonable, FIFRA requires that the Agency consider the risks (occupational and ecological) associated with pesticide use and benefits and possible methods of risk mitigations.

The Agency has identified occupational and ecological risks associated with use of mancozeb on vegetables including cucurbits, pepper, and tomato. The Agency is considering potential mitigation to address occupational worker and handler and ecological risks. Worker risks may be mitigated by increasing the required re-entry interval (REI) for workers entering fields after a mancozeb application has been made. Mitigation to address occupational handler risks include 1) requiring use of APF10 respirators and additional personal protection equipment (PPE) for mixers, loaders and applicators when utilizing any mancozeb formulation; 2) requiring a closed loading system for mixers and loaders when utilizing dry flowable and wettable powder formulations; and 3) prohibiting use of mechanically pressurized handguns. Potential mitigation to address ecological risks include requiring measures to reduce pesticide spray drift and run-off.

The purpose of this memorandum is to present information on the use, usage, and benefits of mancozeb use in cucurbits and pepper and tomato production. In addition, the impacts of potential mitigations to reduce identified risks are discussed. In separate memorandums, BEAD also assessed the usage and benefits of mancozeb on other agricultural and non-agricultural crops, including seed treatment uses. These memoranda 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 cucurbit and pepper and tomato crops. The benefits of mancozeb in these uses 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 reviews production data to identify major production regions for each relevant crop or crop group. BEAD also evaluates mancozeb usage data to identify use patterns, including variations in regional and seasonal usage such as average application rate, frequency of application, and methods of application. BEAD reviews pesticide usage and 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 peppers and tomatoes and cucurbit crops use mancozeb.

BEAD then evaluates the magnitude of benefits per acre by assessing the biological and economic impacts that cucurbits and peppers and tomatoes 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, grower surveys, and considering economic factors. Impacts to a grower using the next best alternative to mancozeb include monetary costs (e.g., from using more expensive chemicals) as well as loss of utility in resistance management, simplicity of use, flexibility, and management and/or integrated pest management programs. There may also be impacts with respect to crop yield loss and/or quality reductions related to diminished pest control.

A similar approach is followed to assess the impacts of possible mitigations on the use of mancozeb to reduce risks. BEAD considers how the potential restrictions (e.g., disallowing use of mechanically pressurized handguns) would affect the ability of users to control pests or affect the costs of using mancozeb.

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 Characteristics

Mancozeb is an ethylene bisdithiocarbamate broad spectrum multisite protectant fungicide in the 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 (FRAC, 2010; FRAC 2018).

Use and Usage

Use

Mancozeb is a broad-spectrum contact fungicide registered for use on a variety of agricultural crops. Mancozeb is registered for use on cucurbit crops (crop group 9), peppers, and tomatoes (subgroup 8-10A). The variety of peppers mancozeb is registered for is undefined on registrations and therefore all pepper types have been assessed in this memorandum. Mancozeb formulations for use on these sites include dry flowables (water dispersible

granules), flowable concentrates (liquid), and wettable powders. Mancozeb applications may be made via broadcast (ground and aerial equipment) or chemigation (sprinkler/overhead irrigations).

Usage

Agricultural usage values presented in this section are national 5-year annual averages (2017 – 2021). Nationally, about 410,000 lbs. of mancozeb were applied to about 220,000 total acres treated of surveyed cucurbits (cucumbers, squash, watermelons, pumpkins, and cantaloupe), on average each year from 2017-2021 (Table 1; Kynetec, 2022a). Nationally, about 220,000 lbs of mancozeb were applied to about 230,000 total acres treated of surveyed peppers (green, sweet, hot, chili, red, and bell) and tomatoes (all tomato varieties except cherry, grape, and tomatillos) on average each year from 2017-2021 (Table 1; Kynetec, 2022a).

Usage information for some registered cucurbits (such as citron melon) and some, less commonly grown varieties of peppers and tomatoes crops are not collected by data providers. Because these crops have little acreage grown in the US, the usage presented in Table 1 is not substantially underestimated. Additionally, BEAD notes that if mancozeb is utilized in these crops the benefits identified herein likely indicate the benefit of mancozeb in these smaller acreage crops as production practices and target pests are anticipated to be similar.

Table 1: Average Annual National Mancozeb Usage in Surveyed Cucurbit, Pepper, and Tomato Crops, 2017-2021

Crop	Percent of Crop Acres Treated	Pounds (lbs) AI Applied	Total Acres Treated	Single Application Rate (lbs AI/acre)	Number of applications per acre
Cucurbits					
Cucumbers	29	180,000	90,000	2.0	3.7
Squash	28	83,000	42,000	2.0	3.6
Watermelons	28	100,000	60,000	1.7	2.1
Pumpkins	15	37,000	22,000	1.7	2.0
Cantaloupes	6	7,000	4,000	2.0	1.3
Peppers	19	40,000	33,000	1.2	2.8
Tomatoes	15	180,000	190,000	1.0	4.6

Source: Kynetec, 2022a,b

The majority of cucurbit, pepper, and tomato acres treated with mancozeb from 2017 to 2021 were applied by growers using ground equipment (including chemigation) (Kynetec, 2022a). Less than 5% each of pumpkin, watermelon, tomatoes, peppers, and cucumbers acres treated with mancozeb were applied aerially (Kynetec, 2022a). There were no reported aerial applications of mancozeb on squash and cantaloupe, suggesting little to no use of this application method (Kynetec, 2022a).

In general, multiple applications of mancozeb were applied to an acre for each crop (Table 1). The average number of applications applied to an acre from 2017-2021 varied by crop; the highest number of applications of mancozeb reported per acre was on tomatoes (4.6 applications per acre, on average) followed by cucumbers (3.7 applications per acre, on average) and the fewest number of applications was reported on cantaloupe (1.3 applications per acre, on average) (Table 1).

Cucurbit crops

Within cucumbers, cantaloupe, and watermelon crops from 2017 to 2021, the majority of reported mancozeb usage, as measured by PCT, took place within the southeast (Florida, Georgia, North Carolina, and South Carolina) within the US (Kynetec, 2022b). On squash, the majority of reported mancozeb usage, as measured by percent of squash treated from 2017 to 2021, took place in the southeastern (Florida, Georgia, and North Carolina) and in the northeastern (Massachusetts and New York) U.S. (Kynetec, 2022b). Mancozeb usage, based on percent of pumpkin treated, was primarily within New York and North Carolina from 2017-2021 (Kynetec, 2022b). The majority of cantaloupe production acres (about 74%) are grown within California and Arizona, where the drier climate facilitates less fungal disease pressure than in the southeast (USDA NASS, 2024). Therefore, the percent of crop treated nationally was lower in cantaloupes (6 PCT) than other surveyed cucurbits (≥15 PCT) (Kynetec, 2022b). While most mancozeb usage in cucurbit crops has been concentrated in the south and northeast, the target pests regardless of location were similar in cucurbit crops everywhere (Kynetec, 2022b).

Tomatoes and Peppers

Similar to cucurbit crops, in tomatoes and peppers, the majority of reported mancozeb usage from 2017 to 2021 was concentrated within the southeast US, as measured by PCT (Kynetec, 2022b). From 2017 to 2021, about 95% of tomato crop in Florida was treated with mancozeb on average each year, as compared to 8 PCT in California (Kynetec, 2022b). About 50 percent of peppers were treated with mancozeb in North Carolina and 38 PCT in Florida annually from 2017 to 2021 (Kynetec, 2022b).

In the following section, BEAD assesses the pest management benefits of mancozeb in cucurbits, tomatoes, and peppers. For each use site assessed in this memorandum, BEAD provides background information on crop production and pest management practices, then identifies target pests and the role mancozeb plays in control, identifies other control strategies, and describes the benefits of the use of mancozeb in comparison to a scenario without the use of mancozeb.

Role of mancozeb and other multisite fungicides in resistance management

Multisite fungicides, such as mancozeb, work by means of a multisite inhibitor MoA. Fungicide resistance prevention and management is an important component of disease management programs because resistant pathogens can cause substantial disease outbreaks leading to

epidemic levels of disease development, yield losses, and the loss of effectiveness of currently used highly efficacious single-site fungicides (FRAC, 2018). The development of resistance to a single site fungicide often results in cross-resistance to other fungicides with the same mode of action (FRAC, 2024). The loss in efficacy of any single-site fungicide to which pathogens have developed resistance can lead to heavier reliance on fewer single-site fungicides that are still effective (FRAC 2018). Single site fungicide efficacy is critical to maintain because these active ingredients are usually systemic and highly efficacious in controlling specific diseases, and multisite fungicides play a critical role in maintaining their efficacy and delay and/or prevention of resistance.

Vegetable Growers News (Egel *et al*., 2022) recommends several single-site and multi-site fungicides for management of cucurbit diseases. Incorporation of multi-site fungicides (mancozeb, chlorothalonil, copper or sulfur) in cucurbit, tomato and pepper spray programs are important for effective control of fungal diseases and fungicide resistance management because single site MoA fungicides (FRAC groups 1, 3, 7, 11, 21, 27, 40, and 45, 49) have specific mode of action with narrow spectrum of pests control, are generally more expensive (Kynetec, 2022a), and are prone to resistance development in fungal pests targeted by mancozeb (FRAC, 2020). The multisite modes of action fungicides are protectant in nature and are generally not very effective in controlling the disease if used after disease establishment (Egel *et al*., 2022 and Kemble *et al*., 2023). Therefore, mancozeb is often used in combination with single site MoA fungicides for season long disease control and resistance management. Comparative efficacy of recommended multi-site fungicides is shown in Table 3 for control of mancozeb's target diseases.

Growers utilize multisite fungicides in their pest control program due to their broad-spectrum activity in controlling fungal pests and resistance management benefits. In regions that face high pest pressures, the growers of cucurbits, tomatoes and peppers crops may need to apply a fungicide ranging from twice per week (Keinath, 2024; Mackenzie *et al.*, 2018; Meadows, 2023) to every 10 days during the growing season. Growers will apply a multisite alone for disease prevention and for resistance management or in combination with one or more single site fungicides for more effective control of pest and resistance management. If mancozeb is included in every or every other fungicide application during the growing season, growers may have to rely on eight or more mancozeb applications per year.

In addition, these multisite fungicides are less expensive relative to most single site fungicides (Kynetec, 2022a). In the absence of mancozeb, a grower is likely to substitute another multisite fungicide, if available, due to the above-described benefits.

Benefits of the Use of Mancozeb

Cucurbits

Cucurbits are grown in many states in the U.S. (USDA NASS, 2024). BEAD analyzes the benefits of use of mancozeb considering cantaloupe, cucumber, pumpkin, squash, and watermelon

together. While exact ranking or prevalence of a mancozeb target pest in cucurbit production may differ by crop, production location and level of pest pressure (i.e., weather) the same pests (downy mildew, anthracnose, gummy stem blight and powdery mildew) are common for cucurbits growers to regularly target (Kynetec, 2022a).

Mancozeb can be used alone but is often used in combination with single site systemic fungicides in cucurbit crops to prevent/manage/control fungal diseases (downy mildew caused by *Pseudoperonospora cubensis*; powdery mildew caused by *Podosphaera xanthii*), gummy stem blight caused by *Didymella bryoniae* and anthracnose caused by *Colletotrichum orbiculare* (Table 2). If not controlled, these diseases can result in crop yield losses and produce quality reduction. Symptoms and damage caused by these diseases in cucurbits are described below.

Downy mildew is an important disease of cucurbits favored by cool and wet weather. Downy mildew will sporulate on underside of infected leaves and may result in death of infected plants (Wyenandt, *et al*., 2020; Keinath, 2018). Downy mildew was listed by growers as a target pest on more than sixty percent of the cucurbit acres treated with mancozeb (alone or in combination with other fungicides) over the period 2017-2021 (Table 2).

Table 2: Major Pests Targeted with Mancozeb in Cucurbit[1] Production (2017-2021)

Disease	Annual Total Acres Treated (TAT)	Percent of TAT[2]
Downy Mildew	136,000	63%
Anthracnose	55,000	25%
Gummy Stem Blight	47,000	22%
Powdery Mildew	34,000	15%

Source: Kynetec, 2022ab.

[1] Surveyed cucurbit crops include cantaloupe, cucumber, pumpkin, squash, and watermelon.

[2]Portion of mancozeb acres treated to control the pest. Acres and percentages do not sum because growers report targeting multiple pests.

Anthracnose disease symptoms include small, tannish-brown spots on the upper leaf surface of infected plants and fruits. Anthracnose can result in defoliation and fruit yield losses (Roberts *et al*., 2023). Turning the infected leaf will reveal pinkish-orange, spindle-shaped lesions. Gummy stem blight symptoms include foliar blight, crown and stem cankers and fruit rot. The pathogen can be easily identified by the presence of fungal fruiting bodies called pycnidia on diseased tissue. It can cause significant damage to crop yields if not controlled. Powdery mildew is one of the most destructive diseases of cucurbits and therefore is very important to control. Powdery mildew symptoms include production of white, fuzzy lesions on infected plant parts. Lesions often first appear on lower leaves. If left uncontrolled, powdery mildew can kill diseased plants.

Table 3: Comparative Efficacy of Multi-Site Fungicides, when Used Alone, in Commonly Targeted Pests in Cucurbit Production.[1]

Fungicide	Downy mildew	Anthracnose	Gummy stem blight	Powdery mildew
Mancozeb	Poor	Good	Fair/Good	Fair
Chlorothalonil	Poor/Fair	Good	Fair/Good	Fair
Coppers	Poor	Poor	Poor	Poor
Sulfur	No control	No control	No control	Fair

Egel *et al*., 2022; Kemble *et al*., 2023.

In general, mancozeb or chlorothalonil are applied in mixture with single site fungicides for disease control. Although other multisite fungicides (copper and sulfur) are registered for use on cucurbits to control fungal pests, their use is limited. Copper has poor efficacy in controlling cucurbit diseases and can be phytotoxic (Ernest, 2013; Cavanagh *et al*., 2024). Sulfur has fair efficacy against only powdery mildew disease in cucurbits, and can be phytotoxic and therefore must be used with caution (Demicone, 2009). Mancozeb and chlorothalonil provide comparable efficacy in controlling fungal diseases (Table 3). Cucurbit growers managing the pests identified in Table 2 use mancozeb and chlorothalonil in combination with single-site MoA fungicides in disease control programs for effective disease control and resistance management (Zitter, 2003; Hausbeck, 2014; Wyenandt *et al.*, 2022).

In order to maintain season long disease control from May to August, growers – particularly those who face high pest pressure - apply fungicides in cucurbits regularly at 5-to-7-day or 7-to-10-day intervals. This equates to approximately 8-12 fungicide applications per growing season (Egel *et al.,* 2022 and Kemble *et al.*, 2024). If rotating between a multisite fungicide (or combination multisite plus single site fungicide) and a single site fungicide, then a cucurbit grower may utilize approximately four applications of mancozeb and four applications of a single site fungicide in the early season and then switch to chlorothalonil (which has a 0-day PHI versus mancozeb's 5-day PHI) during harvest which occurs over a period of weeks. At least three applications of chlorothalonil are anticipated to be needed during the harvest period. Under registration review, EPA has proposed a maximum allowed annual rate of chlorothalonil will limit growers to apply approximately 3- 4 applications of chlorothalonil (EPA, 2023). Therefore, if mancozeb is not available, growers would likely have to incorporate copper into their spray control programs for season long disease control and resistance management. As a result, growers are likely to experience yield loss and reduction in quality of produce. In addition, resistance management in fungal pests would be compromised.

Tomatoes

In the U.S., tomato production predominantly occurs in California, which accounts for nearly 80% of harvested tomato acres annually (USDA NASS, 2024). Florida is the second largest producer of tomatoes, accounting for about 8% of harvested tomato acres. Most of California's tomatoes are for processing while most of Florida tomatoes are for the fresh market. The rest of U.S. tomato production (about 12% of harvested acreage) is primarily in the Midwest and

Northeast (USDA NASS, 2024).

BEAD's analysis covers California and Florida because these two states produce the majority of the tomatoes grown in the US and these two states have very different climates to favor different diseases and disease pressure. Moreover, Kynetec (2022a) reports pesticide usage data on tomatoes from California and Florida only. The benefit conclusions for tomatoes grown in Florida also applies to tomato in the Midwest and Northeast because these regions face pests and pest pressure similar to Florida during the growing season.

Even though Florida produces less tomatoes than California, Florida tomato growers relied more heavily on mancozeb use than California growers over the 2017-2021 period; survey data reports a PCT of 95% for tomatoes grown in Florida and 8% for California (Kynetec, 2022a and 2022b). Tomato growers in Florida used nearly eight applications of mancozeb per year on average whereas California growers used one or two applications of mancozeb per year on average between 2017-2021 (Kynetec, 2022a). This difference is likely due to high disease pressure in Florida because of weather conditions (hot, humid, and wet weather) favoring disease development (FL, 2006).

As reported in Table 4 below, mancozeb is used for controlling early blight (*Alternaria solani*) and other diseases including target spot (*Corynespora cassiicola*), late blight (*Phytophthora infestans*), and bacterial spot (*Xanthomonas* spp.) diseases (*Pseudomonas syringae*) in Florida. In California, mancozeb is mainly used on tomato for controlling bacterial speck, early blight, and late blight diseases (Table 4; CA, 1999).

Table 4: Annual Average Total Acres Treated (TAT) with Mancozeb for Top Target Pests of Mancozeb in Tomatoes (2017-2021)

Target Pest	Florida		California	
	TAT	% TAT*	TAT	% TAT*
Early blight	111,000	69	8,000	25
Target spot	77,000	47	NR	NR
Late blight	59,000	37	8,000	24
Bacterial spot	54,000	34	3,000	10
Bacterial speck	24,000	15	26,000	84

Source: Kynetec, 2022a
NR= Not Reported
*Summed percentages exceed 100% because growers report targeting multiple pests with the same treatment.

Early blight causes leaf spots, defoliation, and yield losses (Jones *et al*., 2016; Schuh and Grabowski, 2023). Target leaf spots are like early leaf blight and can also be confused with bacterial leaf spot, and can result in heavy yield losses (Bayer, 2024; Pernezny *et al*., 1996). Late blight disease is a potentially devastating disease of tomato, infecting leaves, stems and fruits and can result in crop failure (Schuh *et al*., 2021). Bacterial spot and bacterial speck spots occur on leaves, stems, petioles, sepals, and fruits, these affect fruit quality and marketable yields (Melanson, 2020).

For controlling early blight disease in tomato, a combination of mancozeb with a copper fungicide, or a FRAC Group 7 (penthiopyrad or boscalid) is recommended (Meadows, 2023; Strayer-Scherer, 2019). Also, a combination of mancozeb with difenoconazole plus cyprodinil or a combination of mancozeb with a strobilurin fungicide is recommended for controlling early blight disease (Meadows, 2023). For controlling target spot disease, weekly applications of a multisite fungicide (mancozeb or chlorothalonil) are recommended and are often applied in rotation or sequence but not in combination prior to disease appearance (Mackenzie *et al.*, 2018). For controlling late blight disease mancozeb and chlorothalonil are recommended in rotation at a 7–10-day interval prior to disease appearance and a mixture of protectant fungicide with single site fungicides after disease appearance (Quesada-Ocampo and Meadows, 2019). For controlling bacterial spot and bacterial speck diseases, copper bactericides, copper bactericides mixed with mancozeb, and/or acibenzolar-methyl are registered and recommended to control the pest; chlorothalonil is not an alternative to mancozeb as it has no activity against bacterial diseases (Meadows, 2023).

For season long fungal disease control in tomato, multisite MoA fungicides (copper, mancozeb and chlorothalonil in FRAC code M01, M03 and M05, respectively) need to be applied at regular 7-to-10-day intervals. Applications are recommended to be made alternated between standalone applications of multisite fungicides and a combination of multisite and a single site MoA (such as a fungicide in FRAC code 3, 7, 11) for effective disease control. The combination of multisite with a single site supports resistance management and more effective control of plant diseases (Meadows 2023; Strayer-Scherer, 2019; Egel *et al*., 2022; Kemble *et al*., 2023).

In the absence of mancozeb, the growers can use other multisite fungicides (chlorothalonil and/or copper) in combination or alternation with single site fungicides to control diseases and for fungicide resistance management (Aerts and Mossler, 2006, Meadows, 2023). However, over the period 2017-2021, tomato growers in Florida applied nearly eight applications of mancozeb and more than seven applications of chlorothalonil on average each year (2017-2021; Kynetec, 2022a). EPA has proposed an annual limit of three applications per year for chlorothalonil in tomato (EPA, 2023), so without mancozeb, tomato growers will not be able to depend on chlorothalonil and may not be able to control disease during the entire growing season.

If mancozeb is not available, then the Florida and the Southeast U. S. tomato growers who target bacterial spot disease would have to rely on copper. Some growers are likely to experience yield and quality losses due to existing copper resistance without mancozeb (Wyenandt, 2022). Moreover, copper resistance would likely spread to or develop in new areas, resulting in more acreage subject to these losses.

Mancozeb provides high benefits to tomato growers in the southeast because it controls bacterial spot disease particularly in areas where resistance to copper (the only alternative) is present in the pathogen. Similarly, mancozeb provides high benefits to tomato growers in California if they need to target bacterial speck because only mancozeb and copper are

available for bacterial disease control and there are resistance issues with copper. In addition, mancozeb provides resistance management benefits to growers.

Peppers

Peppers grown in the U.S. can generally be categorized into sweet pepper (bell or banana) or chili pepper (Anaheim, cayenne, cubanelle, jalapeño, poblano and serrano). USDA NASS provides production data for bell peppers and chili peppers. Bell peppers are produced in many states in the U.S. with most production occurring in the southeastern states of Florida, Georgia, North Carolina as well as out west in California (USDA NASS, 2024). There is also notable production in the Northeast (New Jersey, New York, Pennsylvania) and Midwest (Michigan and Ohio) (USDA NASS, 2024). Most chili pepper production is in New Mexico, Arizona, California, and Texas (USDA NASS, 2024).

Table 5 below provides top target pests of mancozeb in peppers (as measured by total acres treated) for both the Southeast and California. BEAD provides usage information for both regions because although the top pests do not differ, the amount of pest pressure differs due to differences in climate (i.e., more growers apply mancozeb to treat powdery mildew in the southeast versus in the west). In peppers, growers use mancozeb to control bacterial spot/leaf spot disease (caused by *Xanthomoans campestris*) (Table 5; Bawden-Davis, 2024; Delahaut, 2004). In peppers, bacterial spot/leaf spot is important as it can cause yield of 23 to 44 percent and quality loss of fruits (Bashan, et al., 1985; Keinath, 2022). While mancozeb is used by some growers in the southeast for control of powdery mildew (Table 5), Dutta et al. (2024) does not explicitly recommend mancozeb for control of downy mildew. It may be that growers in the southeast are predominantly using mancozeb for bacterial spot/leaf spot control but some of those applications are also made to prevent powdery mildew. Sulfur is the only alternative multisite fungicide registered. It is not very efficacious in controlling powdery mildew and can be phytotoxic to peppers during hot weather (about 90°F). There are many single site fungicides that can be used for control of powdery mildew and it appears mancozeb provides additional benefits in controlling powdery mildew in cucurbits when it is used to target other pathogens.

Copper and mancozeb are the only fungicides that have a multisite MoA and are registered for controlling bacterial disease control in peppers in field. Streptomycin is registered for use on pepper seedlings in greenhouses to control bacterial disease and is not registered for fields use in peppers. Bacterial spot/leaf spot has developed resistance to copper, which no longer provides commercially acceptable disease control (Wyenandt, 2022). Therefore, growers use a mixture of copper and mancozeb to control bacterial disease in peppers (Egel *et al*., 2022; Keinath, 2022). Florida and North Carolina (Meadows, 2022) document that mancozeb enhances the efficacy of copper in controlling bacterial leaf spot disease and is the only treatment for effective control of bacterial spot disease. For controlling powdery mildew (caused by *Leveillula taurica*) in peppers, growers use mancozeb (Kynetec, 2022a) as a multisite MoA fungicide in alternation with azoxystrobin.

Table 5: Annual Average Total Acres Treated (TAT) with Mancozeb for Top Target Pests of Mancozeb in Peppers (2017-2021)

Target Pest	Southeast (FL, GA, NC)		California	
	TAT	% TAT*	TAT	% TAT*
Bacterial spot/ leaf spot	21,900	74	1,500	77
Powdery mildew	6,600	22	<100	<1

Source: Kynetec, 2022a.
*Total Acres Treated. Summed percentages exceed 100% because growers report targeting multiple pests with the same treatment.

Mancozeb provides high benefits to peppers growers as it controls bacterial spot disease and there is no effective alternative to control it. Without mancozeb, pepper growers would 1) have to replace mancozeb applications with additional applications of copper and resistance to copper would likely get worse and spread, or; 2) use additional applications of chlorothalonil (which may already be fully used by some pepper growers). Without mancozeb growers face yield and quality losses in peppers.

Impacts of Potential Human Health Mitigation

Restricted-entry Interval (REI)

The Agency identified occupational post-application risks of concerns for workers entering fields to place or move handset irrigation pipe in cucurbit, pepper, and tomato production. To address these risks, the Agency may consider requiring an REI of up to 3 days. Mancozeb labels currently require either a 24-hour or 48-hour REI. Mancozeb is applied at intervals of approximately 7 to 10 days throughout the growing season except for close to harvest because mancozeb labels require a PHI of 5 to 7 days. BEAD examined potential activities that may be affected by a longer REI.

Table 6 below lists the in-field activities, excluding harvest activities, that could potentially occur in cucurbits, tomatoes, and peppers. Harvest activities were excluded because as mentioned, mancozeb has a PHI of 5 to 7 days and so growers are already accustomed to using other fungicides close to harvest of cucurbits, tomatoes, and peppers, if applications during that time are needed. Activities provided in Table 6 were identified using budget line items prepared by university extension; while all activities might not be required in all production systems or all crop varieties/cultivars, the below list is intended to capture what may be required. These activities may require workers to enter a field and therefore these identified activities are those that could potentially be disrupted if the Agency were to increase the REI for these crops.

Table 6. In-season activities that may occur in cucurbit, tomato, and pepper production[1]

Cucurbits	Tomatoes	Peppers
Managing irrigation system	Managing irrigation system	Managing drip irrigation system
Scouting	Scouting	Scouting
Staking and stringing	Staking and stringing	Staking and stringing
	Pruning/suckering	

Sources: NC State, 2024; Purdue University, 2024; University of Florida 2021a, 2021b, and 2021c; University of Georgia, 2024; Talley Jr. and Zandstra, 2012; Turini *et al*., 2018; Wade *et al*, 2020; Kelly and Boyhan, 2009.
[1] Excludes transplant, mulching and harvest activities.

A longer REI means that a grower will have less overall flexibility over the course of the growing season to apply mancozeb applications which can be time sensitive and weather driven. Staking and stringing is anticipated to occur only once over the course of the season while scouting may occur more regularly. A grower may only need to enter a field to manage an irrigation system when a breakdown occurs or if a grower is utilizing a handset irrigation pipe that requires a grower to move the set throughout the season.

A 3-day REI will likely be manageable but will require for growers to do advanced planning so that any time sensitive production activities can be scheduled prior to an application or can wait until the REI expires. However, growers may experience impacts if unplanned circumstances occur such as a breakdown in an irrigation system just after a mancozeb application is made. If a grower must wait three days to enter the field to resolve an irrigation issue this could be problematic and costly for growers (e.g., yield losses could result). BEAD also notes that because it exceeds 48 hours, under the Worker Protection Standard, growers or operators may then be required to post signage to prevent workers from entering a treated field. This requires the labor time to post those costs for the signage if a grower does not already own signage.

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 an 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 and relatively inexpensive. 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, if available for the designated use site (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. While most applications of mancozeb in cucurbit, tomatoes and peppers were made using DF formulation, most applications were made via groundboom and therefore most growers may be unaffected 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 and, in some cases, twice the cost per acre when compared to the most commonly used formulation type (the DF) (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.

Prohibiting use of Mechanically Pressurized Handguns

The Agency is considering prohibiting use of mechanically pressurized handgun applications of mancozeb. The Agency conferred with the United States Department of Agriculture Office of Pest Management Policy (USDA OPMP) to understand use patterns of mancozeb in cucurbits, tomatoes, and peppers, among other crops, including the use of mechanically pressurized handguns. USDA OPMP (2022) reported that the use of mechanically pressurized handgun applications is not a common application method in commercial farms. Therefore, most growers would not be impacted by this mitigation. However, there is some uncertainty of how impactful this mitigation measure will be as this method of application may be used for very

small, diversified operations. BEAD welcomes comment on the impacts that the loss of mancozeb application using handguns would have.

Bystander Spray Drift Mitigation

Buffer Requirements

To mitigate spray drift risk to bystanders (which will also improve any spray drift risks for non-target species), EPA is considering requiring spray drift buffers. In this section, BEAD describes the impacts on mancozeb users of requiring buffers ranging from 25 to 100-feet, where larger buffers could be associated with aerial applications.

For some growers, even a 25-foot buffer may have substantive impacts. Growers who would be required to implement a buffer have three main 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) use mancozeb to treat only the interior of the field and leave the buffer areas untreated. Regarding the first option, if growers do not have another multisite fungicide to substitute (e.g., they have utilized all chlorothalonil applicators or need to target a bacterial pest) then impacts are anticipated to be high with yield and/or quality losses in high pest pressure areas for tomatoes and pepper. In cucurbits growers would have to rely more on single site fungicides but this could risk the development of resistance and ultimately lead to yield and/or quality losses. The second option listed would likely 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. 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. 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 as may be the case for cucurbits, tomatoes, and peppers. Larger buffers impact a larger proportion of the field than smaller buffers. To characterize the effect that buffers may have on growers, Table 6 shows what proportion of a field is affected by different sizes of no-spray buffers for different sized fields. To illustrate the effect of a buffer, consider a rectangular field with 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. A 25-foot buffer results in the loss of 2% of a 50-acre field, but 12% of a 1-acre field. A 100-foot buffer results in the loss of 10% of the 50-acre field, and 68% of the 1-acre field. 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 6. Illustration of percent of fields of various sizes lost to in-field buffers of various sizes.[1]

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

[1] 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.

The majority of mancozeb applications to cucurbits and peppers and tomatoes from 2017 to 2021 took place with ground application equipment (Kynetec, 2022a). Across all peppers, tomatoes, and cucurbits (cantaloupe, cucumber, pumpkin, squash, and watermelon), less than 5% of total acres were treated with mancozeb aerially from 2017 to 2021 (Kynetec, 2022a). USDA OPMP (2022) feedback regarding the importance of aerial applications of mancozeb broadly noted that aerial applications can have high importance in situations "where bad weather and soggy fields preclude ground applications." This is important because the need for broad-spectrum protectant fungicides such as mancozeb can be very important in precisely these situations, after large rain events where renewed foliar fungicide coverage is needed quickly." Therefore, only a small subset of growers may rely on aerial applications of mancozeb but for these growers aerial applications of mancozeb may be important. If subject to a larger buffer because they are using aerial applications, these growers may have to leave these edges untreated which could be yield or quality losses or utilize an alternative chemistry that allows for a smaller buffer (for discussion of available alternatives see Benefits section above which discusses available alternatives and what growers may have to do if mancozeb is not available).

Other Buffer Options

Given that buffers can have high impacts on a grower, EPA may consider additional options that offer growers additional flexibility such as only requiring spray drift buffers when winds are blowing in the direction of a non-target site.

EPA may also require smaller buffers when using drift reduction tools for applications made by groundboom, such as hooded sprayers or windbreaks/shelterbelts. This would reduce the burden of the mitigation by giving growers additional flexibility in applying mancozeb; however, growers may incur some up-front costs to use these tools. The burden of purchasing a hooded sprayer or installing windbreaks/shelterbelts may be greater for smaller operations, which may face higher per-acre costs for equipment and potentially higher financing costs.

Windspeed Restriction

Currently some mancozeb labels require that an applicator not make an application when the windspeed is greater than 15 mph. To mitigate spray drift risk to non-target species, EPA is considering prohibiting groundboom and aerial applications when the wind speed is greater

than 10 mph. Wind conditions vary across the U.S. and wind speed restrictions could prevent timely applications of mancozeb.

Mandatory wind speed restrictions complicate pest and crop management by reducing the available time to make applications and make it more likely that a grower may need to alter pest control plans. Changing plans may result in additional costs. If applications are not made in a timely manner, pest control could decline, potentially leading to additional applications, which may result in yield losses, and/or accelerate the development of resistance. In the case of fungicides in particular, disease prevention and early control are critically important because irreversible crop damage can occur very quickly if a disease goes uncontrolled.

In conclusion, a 10-mph wind speed maximum may prevent, in some cases, the timely application of chemical controls, resulting in reduced yield and quality of the crop and increase costs to growers. The Agency welcomes comments from growers and applicators about their fungicide application practices considering wind speeds.

Medium or coarse droplet size

The Agency is considering requiring a medium or coarse spray droplet size for cucurbits and tomatoes and peppers because coarser droplets have been demonstrated to decrease off-target spray drift and, therefore, may reduce potential exposures to non-target species. However, coverage tends to decline with larger droplets because the droplets hold together rather than spread out over the foliage which could result in a potential reduction in efficacy. As a contact fungicide, mancozeb's efficacy is dependent on coverage. Generally, fungicides are applied using fine to medium droplets (Grisso *et al.*, 2019). Because of this, BEAD anticipates that growers can use a medium droplet size for mancozeb applications without experiencing reductions in efficacy. If EPA were to require coarse droplets in the case of mancozeb, growers may experience decreased efficacy. Growers could compensate by increasing application rates, if allowed by the label, making more fungicide applications, or using alternative products, which could increase production costs or lead to yield loss. Mandating a larger droplet size could also limit growers' ability to tank mix multiple chemicals if partner chemicals require smaller droplet sizes to be efficacious. This could result in growers making sequential applications, increasing labor and fuel costs. EPA encourages comments on any potential impacts to growers from specifying a mandatory minimum droplet size on product labels.

Impact of Potential Ecological Mitigation

The Agency is also considering risk mitigation measures to reduce the risks of mancozeb to non-target organisms by reducing pesticide spray drift and runoff. In this section, BEAD assesses these measures that would reduce ecological risks of mancozeb. The potential mitigation options evaluated include mandatory spray drift measures (buffer requirements, a minimum droplet size requirement, a maximum windspeed restriction), aqueous runoff mitigation

(prohibiting applications of mancozeb when it is raining) and a requirement that growers obtain and follow Bulletins Live! Two labelling.

Spray Drift Mitigation

The spray drift measures as discussed as a part of the human health mitigation are also be considered to reduce risks to off-target species. The impacts of these were discussed above.

Aqueous Runoff Mitigation

48-hour rainfall restriction

BEAD expects a 48-hour restriction on applications prior to rainfall can be highly impactful to users of mancozeb, as periods of wet weather are when plants are most vulnerable to foliar diseases. Coating plants with a protective fungicide such as mancozeb prior to rain events helps to prevent the initiation infection and spread of disease; for this reason, fungicide applications are commonly recommended to be applied before a rainfall event (Egel, 2021; Quesada-Ocampo, 2023). Protectant fungicides such as mancozeb work best when applied during sunny and dry conditions (Cato, 2020; Schilder, 2010). When allowed ample time to dry (at least a few hours), protectants will continue to protect until rain events occur. While older formulations of protectants are more susceptible to wash-off, newer formulations with stickers/adjuvants are more resistant to wash-off by rain. In general, university agricultural extension recommendations advise that growers apply contact fungicides at least a few hours or up to 24 hours before rain (Cato, 2020; Paul, 2016; Schilder, 2010; Warmund, 2018). However, to restrict mancozeb applications 48 hours before a rain event limits users' flexibility in using mancozeb to protect crops against fungal diseases during vulnerable wet weather events, which could lead to suboptimal disease control and/or prompt users to switch to an alternative fungicide. In the case of mancozeb, growers may have no other synthetic multisite fungicide options available to turn to during these periods; this may be the case when mancozeb is already being utilized for other applications over the growing season.

The likelihood of a grower being impacted by a 48-hour restriction on applications prior to rainfall would vary based on the time of year when mancozeb (which will vary by crop as some crops rely on mancozeb applications throughout the growing season) is being applied and the prevailing frequency and intensity of rainfall in the area.

No applications of mancozeb when it is raining

To reduce the potential for runoff, the Agency is considering prohibiting mancozeb applications during rain. The Agency 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.

Impacts of requiring that growers obtain and follow 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 use 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 (EPA, 2022). 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. Growers must obtain the relevant bulletin and check for additional mitigation no earlier than six months prior to the intended application. Some requirements may be more stringent in a Pesticide Use Limitation Area and could even prohibit use for the designated area. If land use practices (additional mitigation measures) are required, growers may need substantial time (potentially more than six months) and careful planning to implement them. The requirement to obtain and follow Bulletins that could change over time, adds additional complexity and uncertainty for operating a farm business.

A recent USDA (2023) report on farm computer usage and ownership reported that 85 percent of farms have internet access, a number that is up from 73 percent in 2017, and a similar proportion of farms own smart phones and/or computers (USDA, 2019 and 2023). However, fewer farms reported using the internet to conduct business. Therefore, while BLT will be easily accessible for most growers. However, for growers who do not have internet at home, accessing BLT requires additional steps who must rather seek other means to access Bulletins relevant to their farm or field. As mentioned earlier, growers not accustomed to accessing BLT as a part of their regular farm business, especially those not accustomed to using online tools to conduct business could face a learning curve but with time and as users become acquainted with this system, this burden will diminish.

Conclusion

Mancozeb is a protectant fungicide having multisite mode of action against fungi and bacteria

causing plant diseases in cucurbits, tomatoes, and peppers. In cucurbit, tomato, and pepper production, BEAD determined that mancozeb provides high benefits because it can be applied consecutively and many times over the course of the growing season with little risk of resistance and at a lower cost than many fungicides. Mancozeb enhances disease control when applied with other chemistries and works to prevent or delay resistance in single site fungicides which can be highly efficacious but resistant prone.

Without mancozeb, growers of cucurbits, tomatoes and peppers in high pest pressure regions would incorporate more single site fungicides into their season-long fungicide rotation, which would result in increased resistance risk which in the future could eventually result in yield and quality losses. Moreover, in tomatoes and peppers, mancozeb combined with copper controls bacterial spot disease and there are no effective alternatives to control this disease in these two crops. Without mancozeb, tomato and pepper growers would incur yield and/or quality losses both in the near and long term. There is no single alternative to mancozeb in tomato or pepper. Moreover, in tomatoes and peppers, mancozeb combined with copper controls bacterial spot disease and there are no effective alternatives to control this disease in these two crops. Without mancozeb, tomato and pepper growers would incur yield and/or quality losses both in the near and long term.

BEAD notes that chlorothalonil is another multisite fungicide also used to fill some of the many fungicide applications needed for cucurbits. Chlorothalonil is currently undergoing registration review and may have fewer available applications than available in the past. BEAD found in its analysis that the reductions in available chlorothalonil applications further underscores the importance of the availability of mancozeb in cucurbit crops assessed in this memo.

The EPA has identified risks to bystanders, occupational handlers (mixers/loaders and applicators) and ecological risks to non-target organisms when mancozeb is applied to cucurbits and in tomatoes and peppers. This memo assessed the impacts of the potential mitigation that may be implemented to address these risks. Some requirements will increase the burden and/or cost of mancozeb use.
The following summarizes the impact of potential mitigation to address human health risks associated with mancozeb use:

- Increasing REI's from one to three days to protect post-application workers entering a mancozeb treated field will likely be manageable but will require growers do advanced planning and post signage to alert workers.
- Additional PPE can result in heat stress and require workers to take more frequent breaks which increases the grower cost of use of this chemistry.
- The closed loading requirement for dry flowable and wettable powder formulations mean that these formulations be contained in water soluble packaging to reduce risks to mixers/loaders is expected to increase grower costs of utilizing mancozeb; there is some uncertainty as to how much costs will increase (may dependent partially for example if special agitation equipment is needed to properly mix a mancozeb with water ahead of

a pesticide application). Worst case scenario, growers could switch to the liquid formulation, but this is anticipated to almost double the cost of using mancozeb.

The following summarizes the impact of potential mitigation needed to address bystander spray drift risks (i.e., buffers, windspeed restrictions to 10 mph, droplet size restrictions to medium and coarse) and runoff mitigation (prohibiting application during rain) associated with mancozeb use:

- Windspeed restrictions reduce grower flexibility when making a pesticide application. A medium droplet size is anticipated to be acceptable for growers utilizing mancozeb.
- The impacts of buffers will vary depending on the size of the buffer and the size of the field affected. A larger buffer is expected for aerial applications, however, few mancozeb applications are made aerially for the crops assessed in this memo (5% or less), so impacts of a buffer may have a large impact but on fewer acres overall. A small buffer of 15-feet for groundboom applications may not be highly impactful for growers but given that the crops in this memo are more likely to be associated with smaller field sizes when compared to major row crops, a buffer greater than 15-feet could have large impacts on growers. For example, a 50-foot buffer on a 10-acre field could equate to a loss of mancozeb use on 11% of that field. If growers cannot apply mancozeb in buffer areas, high yield losses are likely in peppers and tomato. In cucurbits, the growers may have to utilize multiple single site fungicides but this is anticipated to increase risks of resistance and ultimately lead to yield and/or quality losses.

In addition to spray drift mitigation to address bystander risks, the Agency may consider additional mitigation to reduce runoff and spray drift risks to non-target organisms:

- The Agency could consider requiring that growers not make a mancozeb application 48-hours ahead of any projected rain event that is likely to result in runoff. This potential restriction on applications prior to rainfall to be highly impactful to users of mancozeb, as periods of wet weather are when plants are most vulnerable to foliar diseases.
- That growers will be required to obtain and follow additional mitigations in Bulletins Live! Two ahead of pesticide application. Even though this web-based system has been in place for many years, the requirement that a grower access and follow Bulletins is relatively new. 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.
- Off target drift of mancozeb would be reduced via the spray drift measures that are being considered to address risks to bystanders.

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