



Use and Benefits of Peroxy Compounds in Arizona Vegetable Production
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The EPA is seeking public comments in response to revised draft occupational and residential exposure and risk assessment for biopesticide uses of the peroxy compounds, hydrogen peroxide, peracetic acid (PAA), and sodium percarbonate. Our goal at this time is to inform the EPA about specific use patterns of the peroxy compounds in Arizona agriculture, and to provide stakeholder input on their benefits, potential alternatives, and safety considerations for workers.

Background

Arizona growers are one of the leading producers of fresh-market vegetables in the U.S., producing vegetables and melons at an estimated total economic contribution of over \$2.5 billion in 2015 (Kerna et al. 2016). This includes about 90% of all fresh lettuce consumed in the U.S. in the winter (Satran 2015). In 2022, the combined value of production for head lettuce, leaf lettuce and romaine exceeded \$969 million, with production on 63,900 acres (USDA 2023).

The agricultural industry depends on the public trust in its ability to produce safe and plentiful food for human consumption. The Arizona Leafy Greens Marketing Agreement (Arizona LGMA) provides oversight, training, and certification to support public health and food safety in leafy vegetable production in Arizona (lettuces, spinach, kale, chard, radicchio, endive, escarole, spring mix, cabbage). The LGMA has set standards for irrigation of produce based on the types of water available. Type A water is “ag water that is unlikely to contain indicators of fecal contamination either due to natural hydrogeologic filtration or through controlled USEPA and state regulated treatment.” Examples include municipal water, private water or farm well water that are delivered through a closed delivery system. Other water sources, including water conveyed through open delivery systems, surface water, and untreated irrigation canal water are considered Type B water. Type B water must be treated prior to its use applied on vegetable crops starting 21 days prior to harvest. This includes overhead irrigation water as well as water used for chemical applications (Leaman and Salas 2019).

One way to treat Type B water is by the application of a product containing hydrogen peroxide (HPO) + peroxyacetic acid (PAA). Various products and formulations with different concentrations of the two active ingredients are available. Many of these products allow chemigations (delivery through sprinklers, a common practice for produce) and include a section titled, “Treatment of Water Used for Pesticide Spray Solutions.” They are also labeled for “Pre-harvest Clean-up Sprays for Spoilage and Decay Causing Organisms.”

Use of Peroxy Compounds on Arizona Crops

According to the Arizona Pest Management Center Pesticide Use Database (Fournier 2017), two of the three active ingredients included EPA’s revised risk assessments have reported uses on Arizona crops: hydrogen peroxide (HPO) and peracetic acid (PAA). The majority of reported applications are for pre-mix products containing both HPO and PAA, with reported uses across a broad range of vegetable crops. The most significant levels of use are reported in lettuces, spinach and a variety of cole crops, including arugula, kale, Swiss chard, broccoli, cauliflower and mizuna. Use is documented to a lower extent on crops such as celery, cilantro, mustards, dill, parsley. Sodium percarbonate has no reported uses in the database but is known to be used as an algaecide in irrigation reservoirs, canals and ponds on golf courses throughout Arizona.

In addition to the premix products with PAA, records include a small number of applications of products with hydrogen peroxide and salts of phosphoric acid (e.g., Oxiphos), primarily on lemons (fewer than 20 records overall).

In Arizona, only custom (for hire) applications require reporting, along with odiferous compounds and any soil-applied applications of active ingredients on the Arizona Department of Environmental Quality groundwater protection list. Based on interviews with end-users in the produce industry and agrochemical industry contacts, we expect actual use of the premix products to be much higher than indicated by reported data, as most overhead irrigations and grower-applied pesticide sprays containing these products do not require reporting in Arizona. Most of the reported applications are likely fungicide treatments applied by custom applicators.

Use of Pre-mixes of Hydrogen Peroxide and Peracetic Acid

Fungicide Treatment

According to licensed Pest Control Advisors (PCAs), OxiDate formulations and similar products have been used for over 20 years in the produce industry, primarily in organic production systems. OxiDate 5.0, a formulation introduced three years ago, has largely replaced OxiDate 2.0. These products are used in foliar spray programs to control fungal pathogens, such as those causing downy mildew on lettuce, and also for diseases like Late Blight or Septoria, especially on celery but sometimes on other crops. They are used to a limited extent as a fungicide in organic produce, in rotation with other chemistries.

According to some PCAs, efficacy of these products on downy mildew in produce is weak compared to other options. However, the products can be quite effective when used against bacterial plant pathogens. Also, these products have a unique mode of action because they work

through the process of oxidation (the transfer of electrons from the cell wall). Because of this, development of resistance is not expected to be possible. This makes these products ideally suited for Integrated Pest Management programs, as they support resistance management goals when used in rotation with other chemistries. Another reason OxiDate isn't used as a fungicide more frequently in the Yuma growing region is because, as a contact fungicide coverage is critical, and many fungicide applications are applied by air. In any case, it is important to our growers to maintain access to these products.

For fungicide treatments, the higher application rates on the label are used (compared to water treatment uses described below). For example, in lettuce for OxiDate 5.0, the 26-54 fl. oz. / 100gal. is used (compared to 5 fl. oz. / 100 gal for water treatment). At these higher rates, the product has fungicide benefits on top of the water-sanitizing effects mentioned in the following section.

Treatment of Water Used for Pesticide Spray Solutions

According to Dr. Channah Rock, University of Arizona Professor and Extension Water Quality Specialist, the peroxy compounds are commonly used as a pre-harvest agricultural water treatment option for leafy greens. The most commonly used products are SaniDate products under a BioSafe Systems' label. There are multiple formulations with varying concentrations of hydrogen peroxide and peracetic acid. Commonly used formulations are SaniDate WTO (70299-19) SaniDate HC (70299-31), SaniDate 12.0 (70299-18), and SaniDate 15.0 (70299-26). Growers are currently using these chemistries according to the label, "to clean irrigation lines or prevent biofouling," but they also benefit from the added effect of reduction of E. coli bacteria in the irrigation water. Water treatment of all overhead (sprinkler) applied water within 21 days to harvest is a requirement of the Leafy Greens Marketing Agreement (LGMA). However, there are currently no labeled chemistries for that use.

BioSafe Systems is currently testing some of these materials in collaboration with Dr. Rock at the University of Arizona. The focus of this research is to evaluate the treatment of water to reduce human health pathogens prior to the water's use for irrigation on produce crops. They are not testing direct applications on produce. Dr. Rock is testing products such as SaniDate 12.0 and SaniDate WTO under the new FDA/EPA protocol to add Human Health pathogens to the label for this use. This testing is expected to be completed in summer 2023. These products are very attractive to the growers since they do not contain any sodium or chlorides and because they break down in the environment into H₂O₂, CO₂, O₂.

Several Pest Control Advisors (PCAs) working with the produce industry confirmed their use of hydrogen peroxide + peracetic acid premix products as a water treatment prior to application of pesticides via overhead sprinkler irrigation, in accordance with LGMA guidelines. They use the premix products (HPO+PAA) as a water treatment to prepare spray solution following instructions on the label. The use rates are low, for example, 5.1 oz/100gal of water for OxiDate 5.0. The product is added to the spray tank and left to settle before adding the other pesticides being used. Most applications are made by ground. These products are very effective. They are used in any situation where Type A water is not available to the grower. In some production areas, only canal water (Type B) is available. Some growers begin these treatments at 21 days prior to harvest, per the LGMA requirements, though many others prefer to treat any Type B

water applied to the crop, regardless of timing. Some retailers require shippers (e.g., Taylor, Fresh Express) to treat Type B water for the entire growing season. One PCA said these are the only types of products he is aware of labeled for water treatment use on leafy green vegetables.

A verification step (testing) is required by LGMA to confirm the efficacy of a product. Growers / PCAs must run a pre-test annually to make sure the rate they are using shows efficacy. They also must test random samples on a monthly basis. The water must be “pathogen free” following treatment. The use of a water treatment and results of the testing must be documented to demonstrate compliance with LGMA requirements.

Advantages of the (HPO+PAA) premix products: OxiDate and similar products are “crop safe,” whereas chlorine, the main alternative, will burn the crop. The product labels allow for overhead sprinkler applications on vegetable crops produced in the Yuma region. Use of an EPA-labeled product has a record-keeping advantage for PCAs. They already produce “L-1080 forms” to document pesticide uses and to communicate instructions for their use to applicators. PCAs list the product use on the 1080 form; in the special instructions they indicate its use as a water treatment / spray solution treatment. Often, these 1080 forms are used for internal record keeping only and are not reported to the state when reporting is not required.

Pre-harvest Clean-up Sprays for Spoilage and Decay Causing Organisms

OxiDate 5.0 is also labeled for “pre-harvest clean-up sprays for spoilage and decay causing organisms on crops.” Sprays can be applied immediately before harvest because there is no pre-harvest interval (PHI). This has the benefit of eliminating soil and plant pathogens prior to harvest, though it is not labeled for, nor does it claim to control, human pathogens.

For Hard, Non-Porous Surfaces, Equipment and Structures

One PCA mentioned the use of SaniDate WTO (HPO+PAA) for irrigation cleaning and disinfection, for drip tape irrigation systems. The products are also used to clean much larger overhead irrigation systems. These types of applications are economical and necessary to ensure public safety by maintaining clean irrigation delivery systems.

Use of Hydrogen Peroxide Products

One PCA indicated the use of a 50% hydrogen peroxide solution for algae control and sanitation in drip tape irrigation systems, for example a product like Fertizona HP50 (https://www.fertizona.com/_files/ugd/512e9f_a66bd58fcd9b4ae9bc70db24b4d6f38e.pdf). Hydrogen peroxide is preferred in place of chlorine. With chlorine, the quality of the product is inconsistent, because chlorines tend to degrade very rapidly. There is potential for product degradation which impacts performance. Use of chlorine may also damage the crop. Procedures for handling the two chemicals are similar in terms of PPE and use requirements. At higher concentrations, hydrogen peroxide must be handled with extreme care.

For periodic cleaning of drip tape, 1.5-2 gallons of 50% product (about 250ppm hydrogen peroxide) is used as a “shock treatment.” This is applied once or twice per growing season to

keep drip tape clean. If growers are using water that is at greater risk of constant exposure to algae issues, they will apply a constant rate injection that flows at 5ppm.

Response to Recommendations in Revised Draft Risk Assessment

In the recommendations section of the revised draft risk assessment, EPA notes the potential addition of PPE (PF10 respirator), as well as potentially lowering application rates, or restricting the application methods on product labels as needed. Based on a review of the tables in the draft risk assessment, it does not appear that the uses we've described rise above the Level of Concern that would trigger additional mitigations. In any case, we note below how potential mitigations or limitations on use might impact current use practices for growers.

For Products Containing Both PAA And Hydrogen Peroxide

As noted, due to the Leafy Greens Management Agreement (LGMA), water treatments for pesticide sprays have become commonplace across leafy green vegetables (lettuces, spinach and various cole crops) in our production systems. These products help growers to manage pathogens, keep irrigation equipment clean, and instill consumer confidence. Several significant drawbacks to the use of chlorine, the only potential alternative, have been noted above. While it is critical to maintain worker safety with the addition of adequate PPE such as PF10 respirators for use scenarios where levels of concern are exceeded, the risk assessment shows that many current uses should not require a respirator. As noted, extremely low rates are used for the water treatment, and thus we would hope these low rates would be well within safety margins for workers, perhaps with the addition of new PPE requirements where necessary. Maintaining access to the uses we've outlined is of critical importance to the Arizona vegetable production industry.

Premix products containing both PAA and hydrogen peroxide are used as described above in rotation with other chemistries in lettuces and other vegetable crops for the control of downy mildew and other plant diseases. While efficacy against downy mildew in lettuce can be limited compared with other available options, the products can be very effective against bacterial pathogens, such as those that cause bacterial leaf spot on celery (Koike et al. 2005). These applications are at the higher end of the use rates. As noted above, these uses play an important role in resistance management given the unique mode of action of these products. And although in most cases effective alternative chemistries are available in conventional production, options are much more limited in organic production, which has seen dramatic increases in production acres in Arizona over the past decade (Palumbo 2022).

For Products Containing Hydrogen Peroxide Only

We are supportive of EPA's recommendation to ensure adequate worker protection, including additional PPE requirements, such as the use of a PF10 respirator for workers handling concentrated product. This level of protection should not be necessary for workers exposed to or applying diluted solution. We are concerned that significant rate reductions or any use limitations that would impact the practices described above could be problematic for our growers, because of concerns with using chlorine as an alternative.

Other Comments Related to PPE and Worker Safety

According to Dr. Channah Rock, who works closely with the produce industry on water quality issues, field workers (non-applicators) frequently report concerns about entering the field after they have seen the level of PPE used by the workers that are dosing at the pump. Most of these chemistries are injected into the sprinkler irrigation system at the pump or ditch intake, so it takes some training and knowledge about the chemical to ensure worker safety. Eye protection, long pants and sleeves, and closed-toed shoes are required. Once the chemical is in the irrigation water, the residual concentration is typically very low, roughly 10ppm or less. However, because other works see mixer-loaders wearing so much protective equipment when working with the undiluted product, they have these concerns. Workers adjusting sprinkler pipe while the chemical is being injected are concerned about their own exposure. We view this as an education issue, and fully support the need to protect all workers according to their exposure risks.

Who We Are

The Arizona Pest Management Center is host to the University of Arizona's expert IPM scientists including Ph.D. entomologists, weed scientists and plant pathologists with expertise in the strategic tactical use of pesticides within IPM programs that protect economic, environmental and human health interests of stakeholders and the society at large.

Dr. Al Fournier is Associate Director of the APMC / Associate Specialist in Entomology, holds a Ph.D. in Entomology, and has expertise in evaluating adoption and impact of integrated pest management and associated technologies. He serves as an Integrated Pest Management Network Coordinator through the Western IPM Center Signature Program, representing stakeholders in the desert Southwest states in EPA registration reviews. Dr. Channah Rock is Professor & Water Quality Specialist and Endowed Chair in Extension Fresh Produce Safety in the Department of Environmental Science at the University of Arizona. She has worked closely with the produce industry in connection with the management of foodborne pathogens in produce production. Mr. Wayne Dixon holds a B.S. in Computer Information Systems and develops tools and data used in IPM research, education and evaluation, including management of the APMC Pesticide Use Database.

Dr. Jay Sughroue with BioSafe Systems, LLC, serves as Area Manager in the Agriculture Division for Arizona, California, Nevada and Hawaii. He works closely with the Arizona produce industry and is familiar with the use of BioSafe Systems products on produce in Arizona and California. He has been collaborating with Dr. Rock on research trials for the past 5 years and has been treating irrigation water for food safety for over 14 years. Donna Bishel is the Director of Regulatory Affairs at Biosafe Systems and a member of the Peroxy Compounds Task Force. As a member of the Task Force, she has worked to develop and submit data in support of Peroxy compound registration review.

These comments are the independent assessment of the authors and the Arizona Pest Management Center as part of our role to contribute federal comments on issues of pest management importance and do not imply endorsement by the University of Arizona or USDA of any products, services, or organizations mentioned, shown, or indirectly implied in this document.

Our Data and Expert Information

Through cooperative agreements with Arizona Department of Agriculture, the Arizona Pest Management Center obtains use of, improves upon, and conducts studies with ADA's Form 1080 data. Growers, pest control advisors and applicators complete and submit these forms to the state when required by statute as a record of pesticide use. These data contain information on 100% of custom-applied (i.e., for hire) pesticides in the state of Arizona. Grower self-applied pesticide applications may be under-represented in these data. In addition, we actively solicit input from stakeholders in Arizona and other Southwest states (Nevada, Colorado, New Mexico and Southeastern California), including those in the regulated user community, particularly to better understand use patterns, use benefits, and availability and efficacy of alternatives. The comments within are based on the extensive data contained in the Arizona Pest Management Center Pesticide Use Database, collected summary input from stakeholders and the expertise of APMC member faculty.

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