USApple

Pollinator Best Management Practices for Apples

HONEY BEE HEALTH COALITION

A USApple publication developed in partnership with the Honey Bee Health Coalition

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Please note that the recommendations contained herein are provided by USApple and the Technical Working Group (listed above) and do not necessarily represent the views of Coalition members. **For more information about the coalition, visit:** https://honeybeehealthcoalition.org/about-the-coalition

Acknowledgments

IN MEMORY OF DR. LARRY GUT

Dr. Larry Gut, Michigan State University entomologist, was contracted to work as the lead technical writer for this BMP document. Sadly, he passed away on September 2, 2021, before the document's completion.

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Executive Summary

This set of Pollinator Best Management Practices (BMPs) for U.S. apple production provides guidance for growers and regulators on pollinator protection in orchards.

The document considers practical production needs and suggests elements of an outreach and education program to foster adoption and implementation of identified practices. The goal of this work is to increase understanding within the U.S. apple growing community of the benefits and opportunities around protecting pollinators while also recognizing the need to protect the crop from pest damage.

Apples are an important pollinator-dependent crop grown for commercial production on 295,000 acres in the U.S., with 192,000 acres in the Western U.S. and another 103,000 acres in the Eastern U.S. (USDA NASS, May 2021). In the western region, Washington, followed by California and Oregon, are the states where apples are grown. In the eastern region, New York, Michigan, Pennsylvania and Virginia are the largest producing states. Throughout this document, special considerations with respect to regional differences between eastern and western apple production are noted.

Introduction

APPLE POLLINATION

- Most apples require cross pollination with compatible apple cultivars or crabapples interplanted within the orchard to ensure good fruit development, e.g., desired fruit shape and size.
- Apples bloom in spring when cold and wet weather conditions can reduce pollination by adversely affecting both pollinator activity and flower viability and longevity.
- After pollination, fruit must be thinned to a certain number of fruits per limb or tree to achieve desired fruit sizing at harvest and return bloom the following season. Thinning is typically accomplished by the application of chemical thinners, some of which may be harmful to bees.
- Recommended pollination practices for commercial apple orchards, including placement of honey bee hives and stocking densities, were developed for low density, central-leader (150-250 trees/A) orchards with free-standing apple trees, a background level of feral honey bee colonies, and pollination services by wild native bees (McGregor, 1976).
- Modern high density (1,000+ trees/A) trellised systems may have different needs with respect to pollinator densities.
- Western U.S. apple growers rely almost universally on commercially managed honey bees for pollination services; some Eastern U.S. orchards can achieve adequate pollination from wild bees.
- The abundance and diversity of wild bees depend on the natural history of the region and the availability of wild bee habitat near orchards.

APPLE POLLINATORS

Apples produce flowers that many kinds of insects can access; however, bees provide the most pollination value. Honey bees were brought intentionally to North America more than 400 years ago, after which feral colonies of honey bees (Apis mellifera) became common. Today, honey bees are now largely absent because of the accidental introduction of the Varroa mite in the 1980s. Honey bees thrive in hives managed by beekeepers and have become the most

#FreshPicks: Elizabeth Pauls

https://vimeo.com/431870906

WILD BEES IN NORTH AMERICAN APPLE ORCHARDS

More than 50 wild (non-Apis) bee species are known to visit apples during bloom and can be grouped into one of the following categories based on nesting biology:

- Ground nesting bees that nest in orchard soils or in adjacent habitat – especially digger bees (Andrena spp.), but also cellophane (colletid) and sweat (halictid) bees.
- Mason bees (Osmia spp.) that nest above ground in pre-existing holes in trees or in boxes supplied with paper straws, natural reeds or bamboo.
- Small carpenter bees (Ceratina spp.) that nest in woody plants with pithy stems (e.g., brambles).
- Wild bumble bee queens collecting pollen and nectar in orchards while they build up their below-ground colonies for the season.

important crop pollinator. Colonies can be rented and placed where they are needed and then moved out once crop bloom has ended. Where wild bees are insufficient in number for pollination, growers routinely contract with beekeepers for pollination services. There are other kinds of bees (e.g., mason bees, bumble bees) that can also be managed for orchard pollination, but availability is often limited. In some Eastern U.S. orchards, wild bees may be abundant and in sufficient number to achieve adequate pollination without adding managed bees.

POTENTIAL HAZARDS TO POLLINATORS FROM APPLE PRODUCTION PRACTICES

Pollinators active in and around orchards, including managed bees hired for pollination services, have the potential to be negatively impacted by pest management practices. Honey bees have a large foraging range, so pesticide exposure can come from a wide variety of sources outside of the orchard for which they were rented. Except for managing and mitigating drift, exposures from outside the crop are generally not something that either individual apple growers or beekeepers can control. However, there are some critical factors that may be overlooked that can minimize unintended exposures of bees to pesticides. Within orchards, sources of pesticide exposure may include:

- When pesticide applications are made in blocks not in bloom but containing blooming weeds within foraging range of hives or wild bee nests.
- When systemic pesticides applied pre-bloom move through treated trees, ending up in nectar or pollen collected from those trees by foraging bees.

MORE ON PESTICIDES AND POLLINATOR HEALTH

- Pesticides with the same mode of action are grouped together into classes and assigned codes by the Insecticide Resistance Action Committee (IRAC), the Fungicide Resistance Action Committee (FRAC), or the Herbicide Resistance Action Committee (HRAC).
- Within classes of pesticides there is variability in relative toxicity to bees. Toxicological data is used by the Environmental Protection Agency (EPA) to determine pesticide risk in the registration of new pesticides and in the review of older pesticides considering new data.
- Pesticide exposure concerns are not limited to insecticides; there is an increasing body of literature and current research focused on the impacts of fungicides, other pesticides, and adjuvants on pollinator health.

HAZARDS WITHIN THE HIVE

- In honey bee hives, pesticides can build up in wax and stored pollen, including pesticides targeting control of Varroa mites.
- Residue exposure can be cumulative as hives are moved among various crops for their pollination services.
- Beekeepers who provide crop pollination services are advised to replace old frames with new frames annually to reduce this in-hive hazard.

Best Management Practices

PROVIDING & CONSERVING POLLINATOR HABITAT & OTHER FLORAL RESOURCES

Habitats containing flowers that are protected from pesticide drift benefit apple growers by providing additional forage (nectar and pollen) to pollinators. They can also provide nesting opportunities for wild pollinators. These habitats also provide food and refuge for agents of biological control – predators (e.g., hover flies, green lacewings, lady beetles) and parasitoids (tiny wasps that attack pests) that help suppress populations of apple insect pests. Depending on the region, different types of habitats can be planted or conserved to provide non-crop flowering plants on the farm. When the crop is not in bloom, these habitats can also help divert bees from fruit plantings.

- Woodlands provide nesting and spring flowers for wild bees important to orchard pollination in the Eastern U.S.
- Wildflower meadows (a.k.a. prairie style pollinator plantings) provide summer and fall blooming resources but require planning, patience and maintenance to implement.
- Mass-flowering, summer-blooming cover crops like sunflowers, canola, buckwheat, etc., may be a good fit where more permanent plantings are impractical.
- Intercropping or polyculture farming may be the best way to provide additional bee forage in parts of the U.S. where water conservation limits the planting of pollinator habitat outside of orchards.

IPM IN APPLES

Integrated Pest Management (IPM) is a sustainable, science-based, decision-making process that combines scouting and multiple management tools (e.g., biological, cultural, physical, and chemical control) to identify, manage, and reduce risk from pests in ways that minimize overall economic and environmental risk, while supporting human health. Pests are defined as any organism (microbes, plants or animals) that poses economic, health, aesthetic or environmental risk. Pests are context-specific, so an organism that is a pest

Establishing Forage

https://youtu.be/OA56vpJ6DCo

HELP WITH POLLINATOR HABITAT INSTALLATION

In each region there are a variety of organizations and programs ready to help with the planning and implementation of pollinator habitats. Some of these programs offer cost-sharing incentives. These programs include:

- USDA Natural Resource Conservation Service and Farm Service Agency (e.g., Conservation Reserve Program, Conservation Stewardship Program, Environmental Quality Incentives Program)
- U.S. Fish and Wildlife Service (e.g., Partners for Fish & Wildlife)
- Various state Department of Natural Resource (DNR) incentive programs
- Non-profit or private groups (e.g., The Bee & Butterfly Habitat Fund, Project Wingspan, Pheasants Forever, The Xerces Society).

in one environment may be benign or beneficial in others. IPM practices are now an integral part of apple production systems, whether these production systems rely on synthetic or organically certified pesticides.

For many apple pests, weather-based or biologically predictive models are available and used to aid pathogen and insect pest management decisions. Successful implementation of these models requires IPM practitioners trained in their use and who are knowledgeable of economic or action thresholds specific to their commodities and production areas. Apple growers rely on a combination of information sources for pest management recommendations including independent crop protection consultants and local extension specialists providing scouting reports and pest management guides. Examples of tools used in combination with predictive models include traps baited with semiochemicals, beat-tray samples, systematic scouting of plant tissues normally affected by target organisms, spore traps and remote sensing.

Pesticides are used in apple production to prevent, kill or suppress pest organisms from causing economic damage to the crop. Pesticides are selected according to many criteria, including their fit in a season-long IPM program managing multiple co-occurring pests. Criteria include efficacy in controlling different life stages of a pest (e.g., egg, larva and adult), cost, compatibility with biological control, regulatory restrictions on use related to target export markets, safety to farm workers, potential to harm non-target organisms and managing against pesticide resistance.

Growers also incorporate tactics to control pests such as biological control, pheromone-mediated mating disruption and other biorational practices as options that may help reduce the need for other pesticide applications. Currently, some key apple insect pests, such as codling moth and oriental fruit moth, are effectively controlled with pheromone-mediated mating disruption as part of an IPM approach, with greater than 90% of apple orchards in the Western U.S. implementing this technology. The practice of mating disruption has reduced the need for companion insecticide sprays by 40%-60% for the targeted insect.

BEST PRACTICES FOR PESTICIDE USE

Record keeping and adhering to federal and state rules and regulations. Applicators are required by law to follow current labels when applying pesticides. Pesticide labels can be found in a variety of places online, including the CDMS.net database (www.cdms.net). All new and recently updated pesticide labels are likely to contain mandatory and advisory language related to bee safety. This language can appear in multiple places within a single pesticide label, but it is often accompanied by an icon of a bee to alert applicators of use restrictions related to pollinators. In addition, many state departments of agriculture maintain their own pesticide use requirements.

- Growers and crop protection consultants should be knowledgeable of state and federal rules and regulations guiding pesticide applications.

MANAGED POLLINATOR PROTECTION PLANS

In 2014, EPA began engaging state agencies in developing state pollinator protection plans as a means of mitigating the risk of pesticides to bees and other pollinators. The primary purpose of a state's Managed Pollinator Protection Plan (MP3) is to reduce pesticide exposure to bees through voluntary actions, timely communication and coordination among key stakeholders, including beekeepers, growers, pesticide applicators and landowners. A state's MP3 is meant to help establish clear expectations among stakeholders when a pesticide application needs to be made near managed pollinators. This open communication will not only help build relationships and increase mutual understanding, but also ensure peaceful co-existence and allow all parties to operate successfully. Most states have MP3s. Visit your state's Department of Agriculture or Extension website to locate and review.

- If not required by law in a particular state, keeping good records of all pesticide applications provides the applicator with the ability to demonstrate that applications were made according to the label if an issue arises. This can also provide a record to evaluate the efficacy or impacts of pesticide applications retroactively.

Pesticide selection and application timing. There are several regional guides available for advising growers and crop protection consultants on the selection of pesticides that are least toxic to bees and other beneficial insects. Important considerations include:

- Consider whether the insecticide or fungicide must be applied during bloom. Can it wait until bee colonies are removed from the orchard?
- When selecting from among pesticides permitted for use during crop bloom, give due consideration to pesticides that are least toxic to bees and other beneficial organisms. For example, for codling moth, granulosis virus products can be effective against the pest while having no effect on pollinators.
- Time applications to coincide with when bees are least active; most bees are less active in cool temperatures and low light, so spraying pesticides after sunset can greatly reduce the risk of direct exposure.
- Daytime applications when temperatures are expected to remain at 50°F or below will generally reduce risk of exposure. However, colony strength, food resource levels within hives and recent weather events that may have inhibited foraging will all combine to influence bee flight activity, even under low temperature conditions.
- For night applications it is recommended to wait until bees have quit foraging before starting a spray application, with a stop time for spraying before 3:00 a.m. to allow adequate time for the application to dry before bees begin to forage in the morning. The drying time for pesticides will differ depending on active ingredient and formulation. Check regional guides for more information.
- Above all, always apply the product according to the label.

Drift prevention and mitigation. Applicators should always think about spray drift prevention and mitigation. This starts with selection of the sprayer, orchard architecture, understanding how tractor application speed can impact deposition and knowing how to calibrate sprayers to maximize coverage and minimize loss to drift. When purchasing new sprayers, look for advances in sprayer technology that help make proper calibration or drift prevention easier to achieve, including consideration of electrostatic sprayers and tower sprayers that easily convert to accommodate different growing systems.

Applicators should be well-versed in how to maintain, modify and otherwise calibrate sprayers to maximize spray deposition to the target site.

- Good calibration tools are available (e.g., https://sprayers101.com/orchardmax) as are calibration training workshops provided by land-grant university extension services and/or state departments of agriculture in most regions.
- Wherever consistent with orchard architecture and topography, shields or diverters can be added to modify existing sprayers to maximize coverage and minimize drift.
- Orchard architecture, canopy density and physical and chemical properties of the pesticides and adjuvants will dictate the best combination of nozzles, pressures, gallonage and driving speed to maximize deposition and minimize drift.

Drift prevention should also include the following:

- Turn off the sprayer near hives and pollinator habitat.
- Turn off nozzles directed out of the orchard in the outer row and end of rows.
- Avoid spraying under windy conditions and during temperature inversions. Many pesticide labels require that growers check for inversion layers in their area before spraying and some states (e.g., Washington) require recording such conditions in their spray records.
- Plant wind breaks where possible and maintain buffers between treated areas and hives or pollinator habitats.

Weed management. Non-crop flowering plants that invade orchard grass row middles and are attractive to bees can become sources of contaminated pollen and nectar.

Boosting Blossoms

https://youtu.be/J5wHwyLP25A

Some growers attach a mowing implement to their sprayer to cut flowering weeds as they apply pesticides to the crop. Selective herbicides may be used to suppress flowering forbs in orchards, but the best timing will depend on the chemical selected.

If flowering habitat has been deliberately incorporated into orchard row middles, it will be important to apply pesticides that are least harmful to bees and when bees are not actively foraging.

Preventing contamination of open water. Honey bees consume large amounts of water for regulating in-hive temperatures. Contamination of open water sources may result in unintended exposures leading to bee poisoning. After applying pesticides, always clean equipment and dispose of pesticide products safely – do not leave contaminated water where bees can access it.

Consider providing a source of clean water for bees within an orchard under a pollination contract.

- Consider testing of irrigation systems well before pollinators are scheduled to arrive to allow time to make any needed repairs and to provide dry conditions within the orchard, thereby reducing the chance of pollinators drinking compromised (contaminated) water.
- Consider using/draining all waste water from pesticide fill sites daily to prevent bees from using waste water as a drinking source.
- Some states have voluntary programs to assist with siting and building pesticide storage facilities to prevent surface and groundwater contamination. One example is the Michigan Agriculture Environmental Assurance Program (MAEAP). Check for similar resources with your state department of agriculture.

WHEN CONTRACTING WITH A BEEKEEPER FOR POLLINATION SERVICES

Communicate expectations. If honey bees will be contracted for pollination services, growers and beekeepers are strongly encouraged to clarify expectations through a written contract that includes plans for record keeping, when and how many hives will be delivered, where hives will be placed on the farm, when they will be removed, planned pesticide use and other conditions to provide for the health of the bees, including provisions of clean water. There should be a meeting between the grower and the beekeeper prior to the spring bloom period to discuss the upcoming bee season. If the grower is not also the pesticide applicator, open communication among the grower, whoever is applying the pesticides for the grower and the beekeeper will be essential. Ultimately, the grower is responsible for communicating with their pesticide applicator.

- Growers/applicators should provide sufficient time between pre-bloom sprays and placement of the hives to avoid direct exposure and to ensure that beekeepers can adhere to restricted-entry intervals (REI) on pesticide labels when placing or removing hives from the orchard.
- Orchardists should give beekeepers as much advance notice as possible on placing and removing hives. Ideally, one week's notice should be given for a prospective date of arrival, and two days' notice when the exact night of arrival is decided upon.

Selecting a suitable location for hives on the farm. To minimize potential for pesticide drift reaching hives, select locations on the farm that are protected from wind, easy for the beekeeper to access and easy for the pesticide applicator to avoid when spraying. Honey bees are highly mobile, so hives do not need to be distributed throughout orchards. Set aside an area on the farm in a sunny location to enhance bee activity.

PEST MANAGEMENT CONSIDERATIONS RELATED TO APPLE PHENOLOGY

Here we provide additional guidance on mitigating hazards to bees with respect to pest management at different crop stages.

Pre-bloom to pink stage:

- When systemic pesticides are selected for use, consider restricting applications to the half-inch green developmental stage or selecting a non-systemic alternative, if an application is needed within 14 days before bloom. The pesticide label may include additional restrictions on use around bloom.

During bloom:

- When selecting from among pesticides permitted for use during crop bloom, consider use of pesticides that are least toxic to bees and other beneficial organisms.
- Consider using biorational alternatives where effective and available (e.g., pheromone mating disruption).

Petal-fall:

Petal fall is the most challenging timing for insecticide use with respect to pollinators in orchards. It is common for blocks to be planted with mixed varieties for cross pollination, or for adjacent blocks to contain later blooming varieties. This can make it difficult to assess when petal fall has been achieved.

- Individual pesticide labels may contain definitions of "petal fall."
- Growers should work closely with beekeepers to coordinate hive removal.
- Drift prevention and mitigation will be critical with respect to adjacent blocks still in bloom or where bees are actively foraging.

EXAMPLES OF KEY APPLE INSECT PESTS ACTIVE AT PETAL FALL:

- Eastern U.S.: plum curculio, San Jose scale, tortricid moths, plant bugs and rosy apple aphids.
- Western U.S.: codling moth, grape mealybug, leafrollers, rosy apple aphids, spider mites, leaf miners, leafhoppers and thrips.

- Consider use of pheromone mating disruption for key moth pests where available.
- Eliminating flowering broad-leaf weeds from orchards will both remove a source of potential pesticide exposure to pollinators and will reduce populations of disease vectoring insects active at this time (e.g., leafhoppers).
- When insecticide applications are used against key pests active at this time, consider insecticides with a short residual, and spray after sunset to minimize exposure to pollinators.

Fruit thinning:

- For materials that are labeled for use during petal fall for fruit thinning, be aware of bee activity in orchards and consider applying thinners in the evening once the bees have stopped foraging for the night.

Remainder of the season through harvest:

- Continue practices that prevent or mitigate spray drift on flowering plants in orchard row middles and adjacent habitats.

Resources

PESTICIDE TOOLS

- Sprayers 101, a non-profit resource describing best practices in safe, efficient and effective agricultural spraying: https://sprayers101.com/
- University of California IPM Bee Precaution Pesticide Ratings database: https://www2.ipm.ucanr.edu/beeprecaution/

WEATHER-BASED PEST FORECASTING

- Cornell University's NEWA system (https://newa.cornell.edu/)
- Michigan State University's Enviroweather: https://enviroweather.msu.edu/
- Washington State University's Decision Aid System (DAS): https://decisionaid.systems/

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