

*PREVENTING DISEASE WHILE MINIMIZING
HARM TO POLLINATORS DURING BLOOM*
**BALANCING PEST MANAGEMENT AND
POLLINATOR HEALTH**

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OUTLINE

- Pollination and Bees
- Pesticide Exposure
- Sub-Lethal Effects
- Best Management Practices



IMPORTANCE OF POLLINATION

“Pollination is without question the most critical event in the yearly production cycle of apples”
- S.E. McGregor 1976



IMPORTANCE OF POLLINATION



Poor pollination

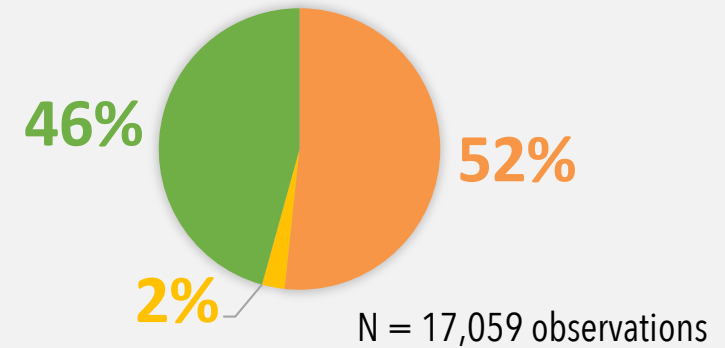


Good pollination

Not every ovule must be fertilized for fruit to develop, but the more seeds there are, the more likely fruit will remain on the tree until harvest.

WHO ARE THE MAIN POLLINATORS IN TREE FRUIT?

- Managed, non-native **honey bees** (52%)
- Wild, (mostly) native **solitary bees** (46%)
 - Mostly ground-nesting *Andrena*; some halictid/sweat bees
 - Some stem-nesting mason bees (including non-native horn-faced bee)
- Wild, native **bumble bees** (2%)



Honey bees



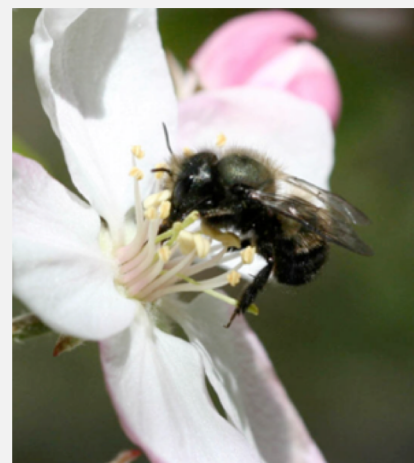
Apis mellifera

Miner bees



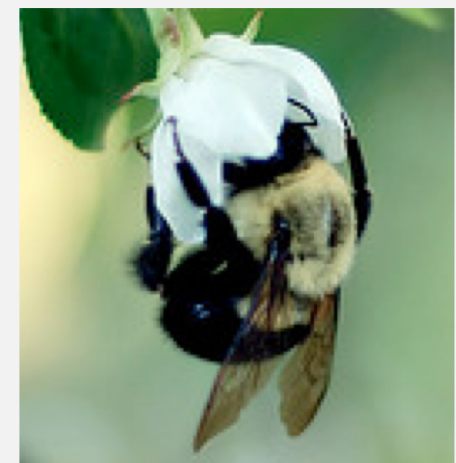
Andrena spp.

Mason bees



Osmia spp.

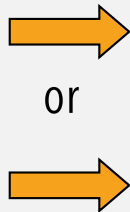
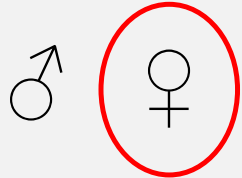
Bumble bees



Bombus spp.

SPRING-ACTIVE SOLITARY BEES

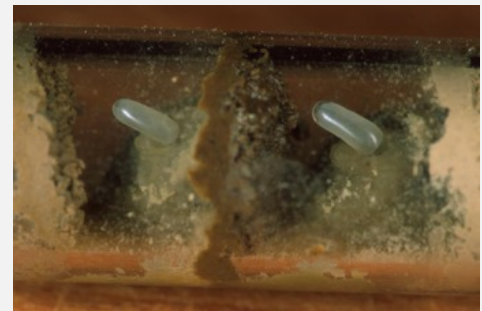
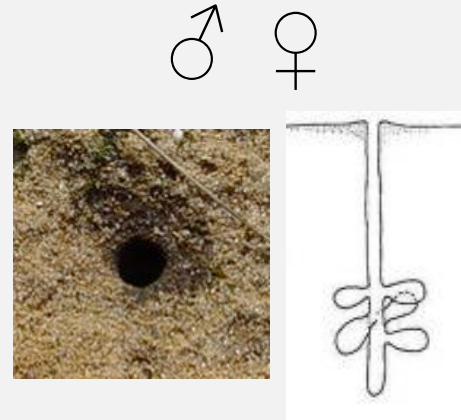
70+ species active in MI orchards during bloom



Environmental cues trigger emergence; males emerge first and await the emergence of females to mate



Individual females gather nesting materials or dig nests in soil and collect pollen and nectar



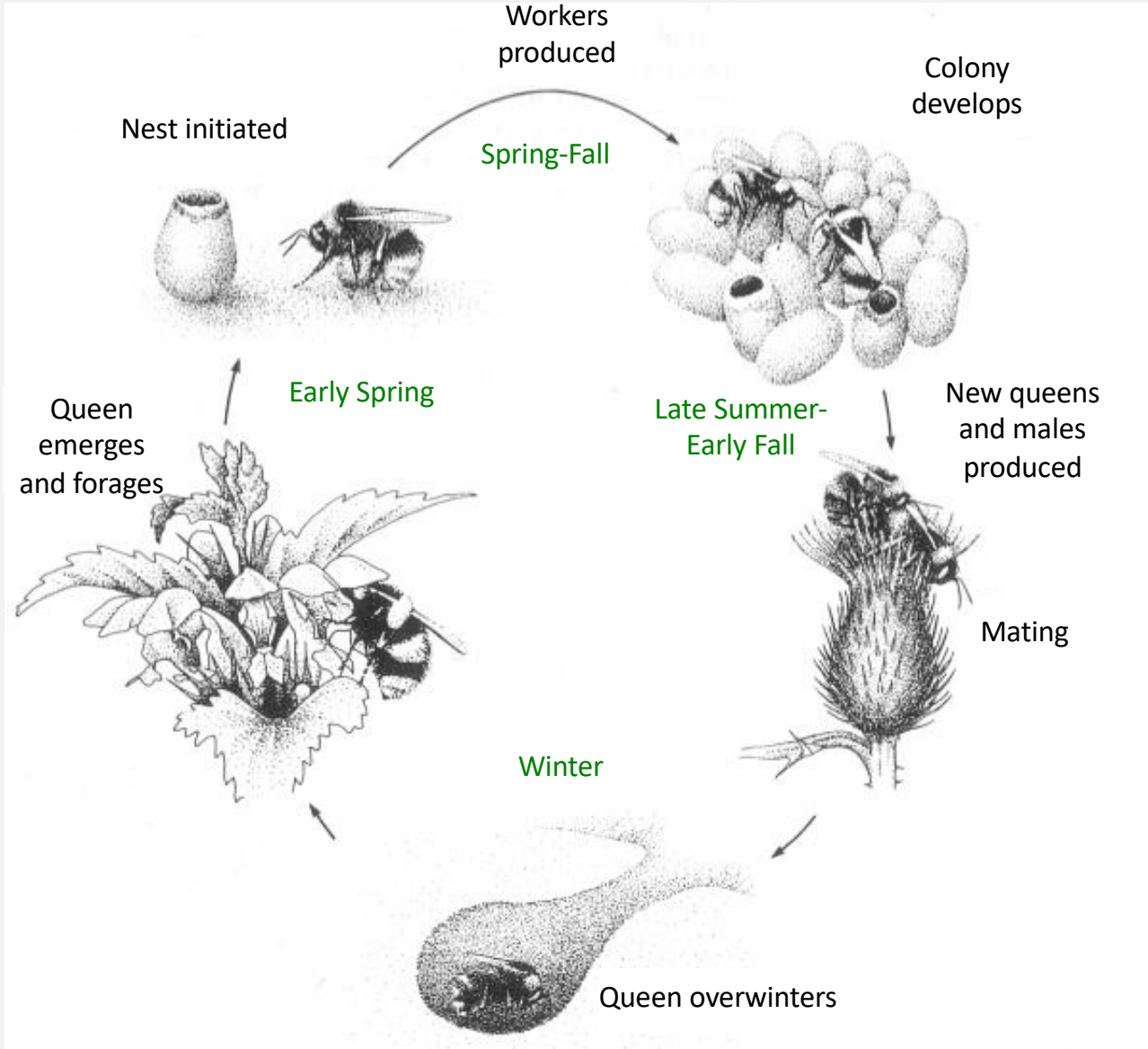
Larvae develop into pupae or pre-adults, that overwinter in the nest cells

*Adults are active for about 3 weeks, depending on the particular species.
New species emerge all season long.*

WILD BUMBLE BEES



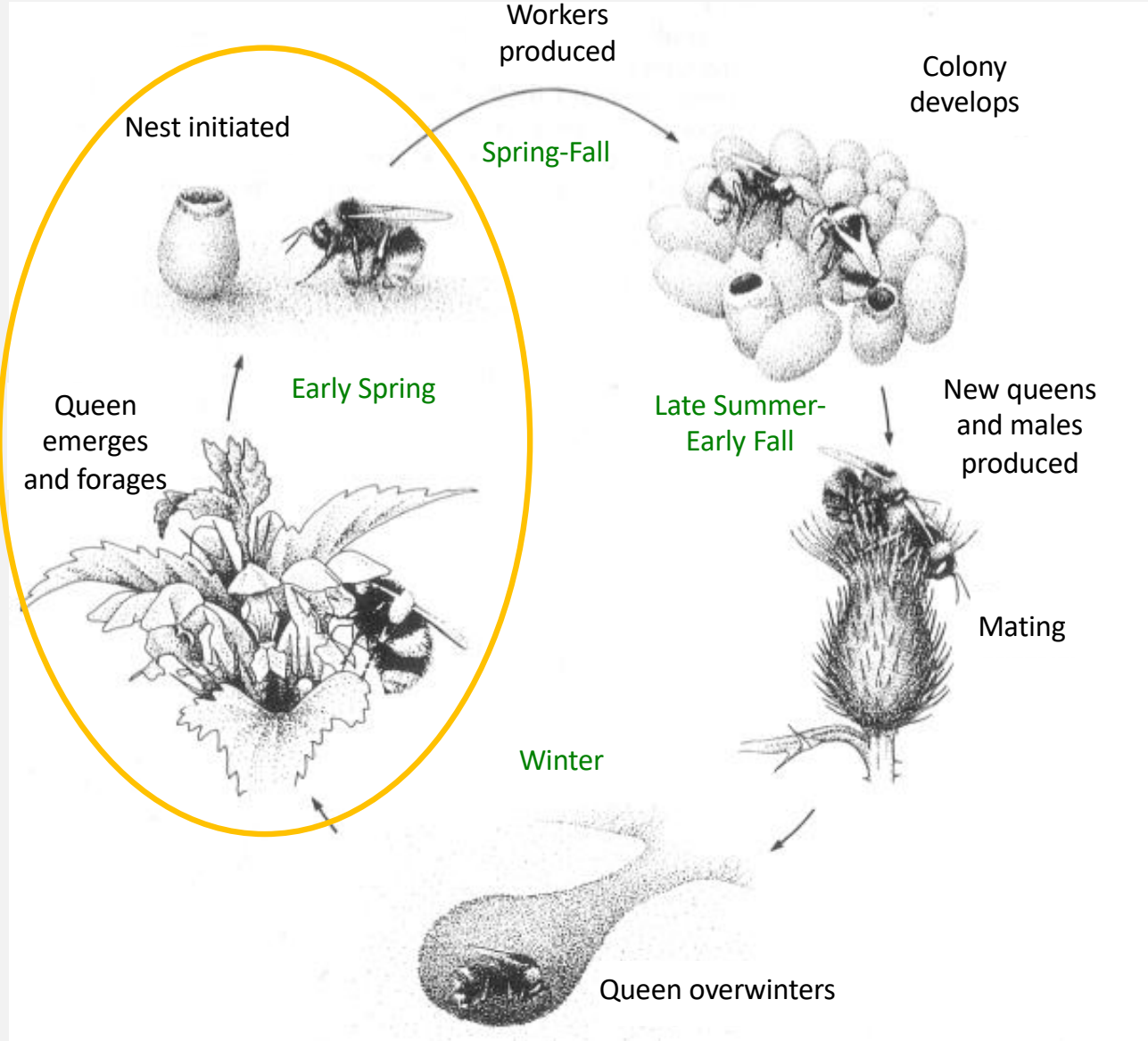
6 common species



WILD BUMBLE BEES



Only queens are available to forage during orchard bloom



HONEY BEES: THE WORKHORSE OF CROP POLLINATION

Colonies are portable, contain thousands of foragers.

Individual hives collect pollen and nectar from many different cultivated and wild plants.

Individual foragers recruit others to visit particular flower patches through waggle dance.

Individual foragers exhibit floral constancy – enabling pollination.



HONEY BEE LIFE CYCLE

- **Queen** lays eggs; controls whether eggs will be drones, workers, or new queens
- **Drones** (male bees) mate with new queens, then die
- **Workers** (female bees other than queen) take care of brood, provide housekeeping in the hive, forage for food, process nectar into honey and pollen into bee bread





Illustrations: Marguerite Meyer

- Three weeks as **Brood** – eggs, larvae, pupae
- Three more weeks until the worker becomes a forager

**IT TAKES 2-3 MONTHS TO BUILD UP A STRONG COLONY
WITH FORAGERS ENOUGH TO PROVIDE CROP POLLINATION SERVICES**



PESTICIDES CAN UPSET THE BALANCE OF THE COLONY



COLONIES OFTEN NEED INCREASED INPUTS TO REBUILD AFTER FULFILLING POLLINATION CONTRACTS



<http://stepplerfarms.com/>

Beekeepers feeding hives to promote growth/rebuilding

More stress during pollination = More input needed by beekeepers

THE BOTTOM LINE

Weak and/or lost colonies



Increased hive rental fees
Less efficient pollination services



Bad for economy and environment

EVERY GROWER OR LAND MANAGER

(EVEN THOSE THAT DON'T DIRECTLY RELY ON POLLINATION)

**CAN GREATLY IMPACT BEE HEALTH
WHEN MAKING PESTICIDE
APPLICATIONS**

TOXIC ACUTE DEATH IS RARE, SUB-LETHAL EFFECTS ARE COMMON

Acute vs. Chronic/Sub-lethal



Report a Pesticide-Related Bee Kill

"Sub-lethal" = does not immediately cause death, but disrupts individual bee health and/or the hive's ability to function properly over time

PESTICIDE EXPOSURE

- Foraging bees will carry resources and pesticide residues back to the hive.
- Bees not in immediate contact in the field can still be exposed through stored hive products.

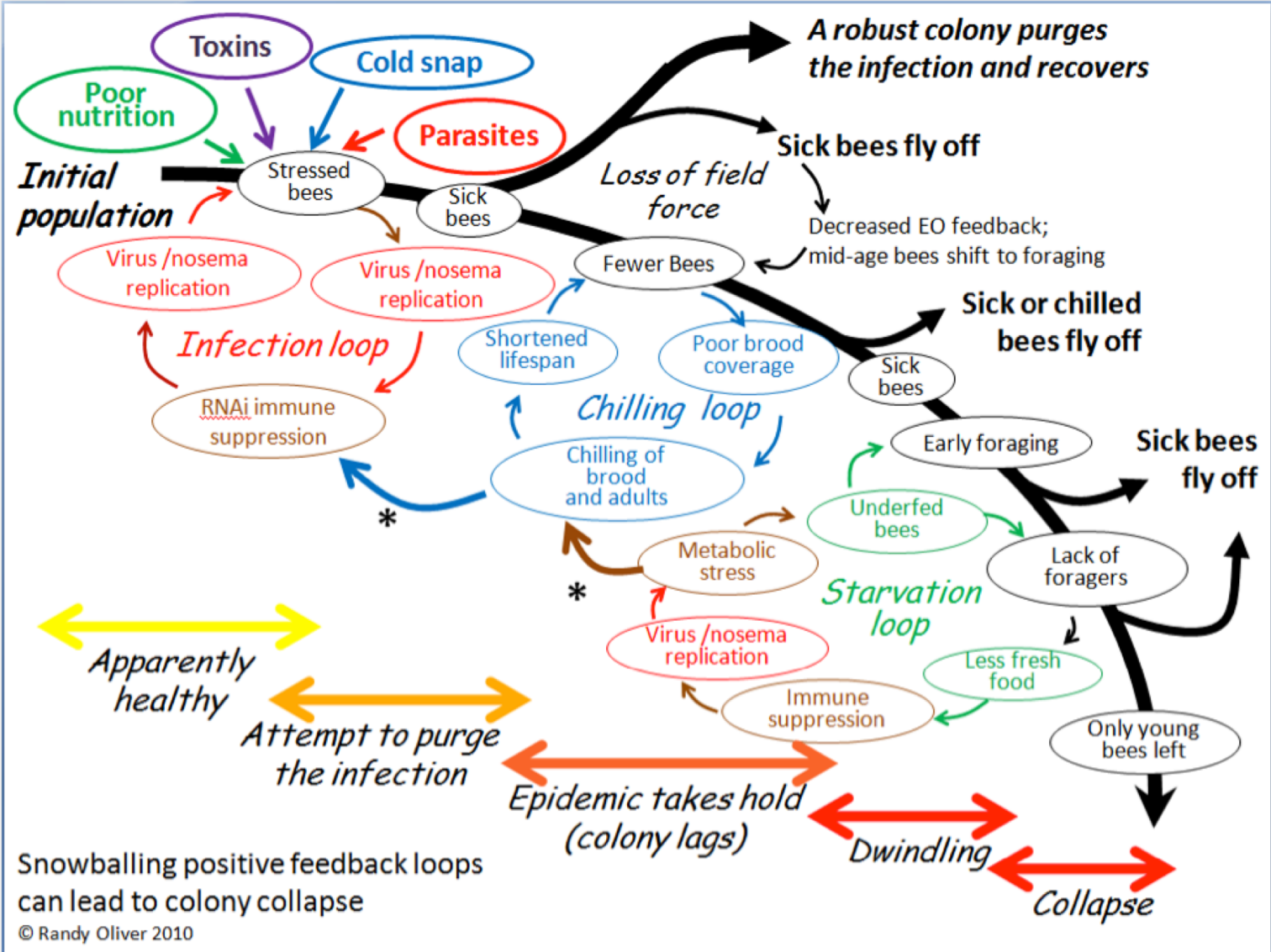


PESTICIDE EXPOSURE

- Stored pesticides can remain in hives for a long period, resulting in chronic exposure.
 - Pesticides are a significant contaminant of bee bread, the main food source for developing bees
 - Bee bread is fermented, and requires active yeasts, fungi, and bacteria
 - Pesticides, especially fungicides can change these important microbial communities



HOW A HONEY BEE COLONY DIES



DO YOU HAVE TO STOP USING PESTICIDES?

NO, however...

Very important to understand the potential risks of using pesticides.

Minimize use as much as possible.

Always follow "Best Management Practices" for reducing exposure.

THERE IS NO LIST OF "BEE SAFE" PRODUCTS

- **Just because products are not labeled as "toxic to pollinators" does not mean the product is safe for bees!**
- Too many knowledge gaps to confidently say that a particular pesticide is completely safe to use around bees
- Focus on using best management practices and avoid particularly harmful substances or tank mixes.

WHY FOCUS ON FUNGICIDES?

- Recent studies have indicated that fungicides have negative health outcomes for bees, despite being largely considered “bee safe”.
 - These products with “sub-lethal” effects are often overlooked
- Fungicides are commonly used when bees are present on site (during crop bloom).
- Fungicide residues found in pollen stores and in wax are significantly higher than residues of herbicides or insecticides.



WHAT DO WE KNOW ABOUT FUNGICIDES?

- Impaired ability to find food and recruit other foragers
- Impaired ability to process and digest food
- Increased disease susceptibility
- Impaired cellular function
- Impaired larval development
- Higher larval mortality



These effects may be compounded when fungicides are combined with other pesticides (negative synergistic effects).

BAD COMBINATIONS

Neonicotinoid

Insecticides:

acetamiprid,
thiacloprid,
imidacloprid

More toxic when
mixed with

Fungicides:

epoxiconazole,
propiconazole,
triadimefon,
triflumizole,
uniconazole-P,
prochloraz,
tebuconazole

Pyrethroid

Insecticides:

deltamethrin,
lambda-cyhalothrin,
alphacypermethrin

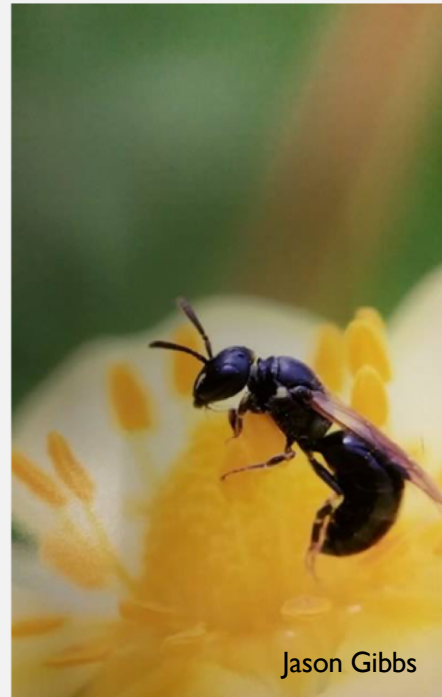
More toxic when
mixed with

Fungicides:

difenoconazole,
carbendazim,
prochloraz, flusilazole,
propiconazole,
tebuconazole,
thiophanate-methyl

KNOWLEDGE GAPS

- Sub lethal effects are highly understudied, including effects in developing bees, and the increased toxicity caused by combined exposures.
- Responses of honey bees to pesticides cannot be extrapolated to responses of native bee species.



PESTICIDE RISK ASSESSMENT

- The EPA has just begun to expand the risk assessment process for pollinator health starting with pesticides that are acutely toxic to adult bees through contact.
- The risk assessment process requires lots of research:
 - Different levels/ doses
 - Different exposure routes
 - Different life stages
 - Different health effects
 - Different contexts

We have to make management decisions long before we will have all the answers

KEY POINTS

- **Everyone can impact pollinators when making applications**
 - Pollination is vital to agriculture, economy, and environment
 - Strong healthy colonies needed for pollination
- Pesticides can cause sub-lethal effects which can lead to colony collapse especially in combination with other stressors
 - Pesticides can interact causing synergistic effects
 - Lots of research still needs to be done

WHAT CAN YOU DO TO REDUCE PESTICIDE EXPOSURE?

TIPS FOR REDUCING EXPOSURE: WORK WITH YOUR BEEKEEPER

Communication

- Develop a pollination contract and bee safety plan with your beekeeper.
- Maintain communication with beekeeper and neighboring farms throughout the season.



TIPS FOR REDUCING EXPOSURE: WORK WITH YOUR BEEKEEPER

Hive Placement

- Don't allow hives to be placed directly in the orchard.
 - Honey bees are excellent fliers and actively seek out orchards in the spring.
- Provide a sheltered location.
 - Tree lines or hillsides provide natural buffers against chemical exposure and other stressors.
- Place hives in fewer, larger groups.
 - Easier on bees and beekeeper
 - Easier to communicate where they are to farm workers so that they can be avoided



J. Albert

TIPS FOR REDUCING EXPOSURE: IPM

Use All Available Tools

- Correctly identify the problem: scout for and know what pests and diseases to expect during the season.
- Learn what methods and tools can be employed to prevent, suppress, and manage pests and diseases as they arise.
- Use the pest and disease models available on Enviroweather to determine when pesticide applications are predicted to be absolutely necessary.

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<https://www.enviroweather.msu.edu>

TIPS FOR REDUCING EXPOSURE: LABELS

- When a pesticide is the tool to use, always **follow label guidelines and instructions for application.**



Look for this icon on pesticide labels for bee-specific warnings.

TIPS FOR REDUCING EXPOSURE: PREPARATION

- **Calibrate your sprayer** to be sure that the material being applied is going where it was intended. You will also save money by not spraying more product than you need (consult *Sprayer 101* for more info; consider using the free OrchardMax app).



TIPS FOR REDUCING EXPOSURE: PREVENTION

- Always **mow or remove flowering weeds in crop area** before applying plant protectants. While these are great alternate sources of nutrition for bees outside the orchard, they can easily become contaminated in the orchard during the season.



TIPS FOR REDUCING EXPOSURE: PREVENTION

Other ways to reduce or prevent contamination of flowers

- Do not apply systemic products prior to crop bloom.
 - Ex: thiophanate-methyl, propiconazole, myclobutanil, and iprodione
- Avoid applications to all flowering plants when possible.



TIPS FOR REDUCING EXPOSURE: PREVENTION

Prevent water contamination

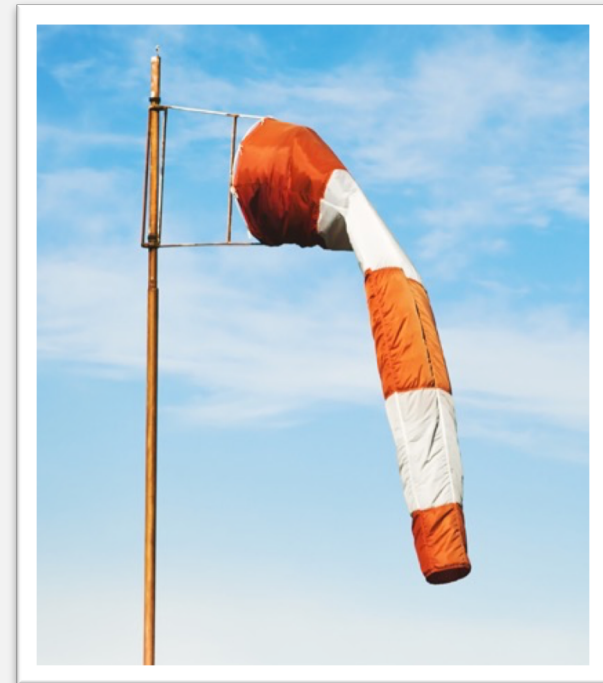
- When filling spray tanks, ensure contaminated puddles are not left behind and that all products are stored properly.



[pinterest.com](https://www.pinterest.com)

TIPS FOR REDUCING EXPOSURE: TIMING

- **Spray when bees are less likely to be active:**
 - After sunset or before sunrise, or when the temperature is below 50 F
 - When wind speed is low (<10 MPH).



TIPS FOR REDUCING EXPOSURE: TIMING

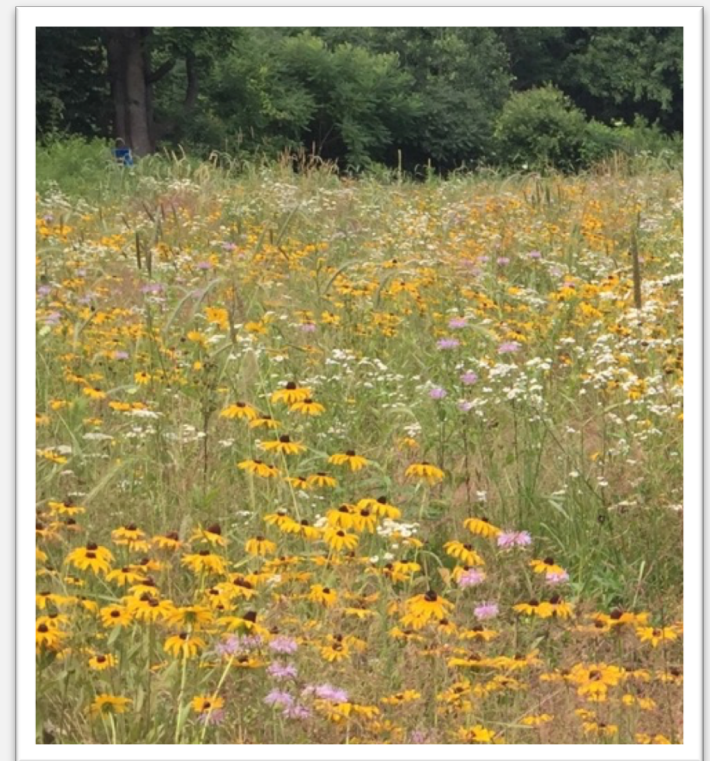
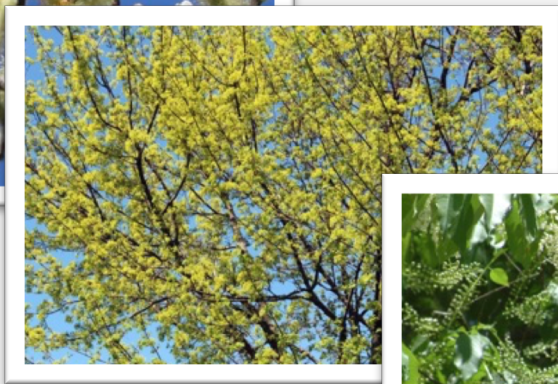
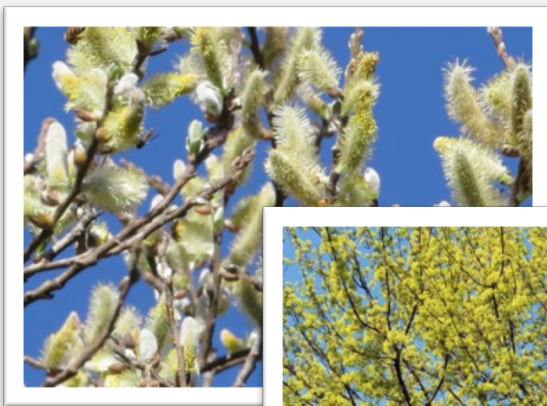
At bloom time, avoid tank mixes

- Fungicides mixed with other pesticides can be more toxic than on their own.
 - Avoid using fungicides with pyrethroid and neonicotinoid insecticides.
- Space treatments of different materials out as much as possible.



TIPS FOR REDUCING EXPOSURE: PROVIDE HABITAT

- **Protect and establish bee-friendly habitat** away from crops.
 - Flowering woody trees and shrubs in adjacent habitat provide additional sources of nectar and pollen for spring-active bees; flowering meadows are a good resource for bumble bees.
 - A diverse diet is better for bee health: better reproduction, disease resistance, ability to detoxify chemicals, and longer life expectancy.



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Pollinators & Pollination

Michigan is a leader in honey production and in many pollination-dependent fruit and vegetable crops. MSU Extension's focus on pollinators and pollination brings together educators and researchers who are working with experts around the country to provide the latest information through webinars, educational seminars, online resources and email newsletters.


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Extension Bulletin E-2973 • New • January 2007

Attracting Beneficial Insects with Native Flowering Plants

Anna Fiedler, Julianna Thell, Rufus Isaacs, and Dong Landis
Department of Entomology, Michigan State University



MICHIGAN STATE UNIVERSITY
EXTENSION

Extension Bulletin E-2988 • New • May 2007

Conserving Native Bees on Farmland

Rufus Isaacs and Julianna Thell
Department of Entomology, Michigan State University

This fact sheet has been developed to provide information for growers of insect-pollinated crops about farm practices that can support native bees. We provide background on the biology of these bees and give practical advice to growers who want to increase native bee abundance on their farms. The habitats a land can offer with Michigan fruit farms, but the information should be relevant to growers across the eastern United States interested in managing their farms to improve desirable pollination of their crops.

Introduction

Bees are essential pollinators of many crops. Pollination occurs when pollen is transferred from male to female parts of flowers, resulting in seed and fruit development. Some plants have light-weight pollen that can be transferred by wind, but most crops have heavier pollen that must be transferred by animals. Insects, however, have been most important for achieving pollination and maximum yields of many crop plants.

Crops that are highly dependent on pollinators to achieve economical yields include almond, apple, cherry, pear, cranberry, blueberry, blackberry, groundnut, soybean, apricot, melon and squash. For some of these crops, bees provide most of the pollination activity as they move from flower to flower to collect food. Some crop plants with lighter pollen grains, such as watermelon, can show higher yields with the addition of honey bees because of improved pollination.

Without bees to move pollen, some crops would be far less productive, and many fruits and vegetables would not ripen as evenly as they do. Without effective pollination, plants produce deformed fruits and vegetables that are not marketable. Estimates suggest that a third of our food is from crops pollinated by bees, and it is important that growers consider strategies to pollinate their crops effectively.

Why conserve native bees? Since their introduction from Europe in 1622, honey bees have become the most economically important pollinator for fruit and vegetable production. Each spring, U.S. growers spend millions of dollars to pollinate their crops. The high number of honey bees brought to crop fields helps ensure that pollen will reach growers' operations. There has been an increasing concern about the decline of native bees, however, because of pesticides and diseases. In addition, several non-native honey bees are increasing. As a result, more attention has been given to conserving wild native pollinators, which are adapted to the local conditions and can help pollinate many food crops.

Overwintering the pollinators that are active on a farm makes good economic sense because it spreads risk across many bee species. This can reduce the chance that poor weather conditions will affect pollination, as sometimes happens in early spring. Another benefit of having more kinds of bees pollinating is that, for some crops, native bees are much more efficient at shaking the flower to release pollen. For example, a honeybee is 10 times more efficient than a native bee at pollinating blueberry flowers.

Most farms already have populations of native bees living in and around fields. Our recent survey of Michigan blueberry farms found that in addition to honey bees brought to the pollinate the crop, native bees such as bumblebees and sweat bees were found on flowers when blueberries were flowering. In this situation, growers get the benefits of large numbers of native bees, but during cool weather, the native bees are better able to fly and pollinate the crop, helping to ensure an abundant harvest.

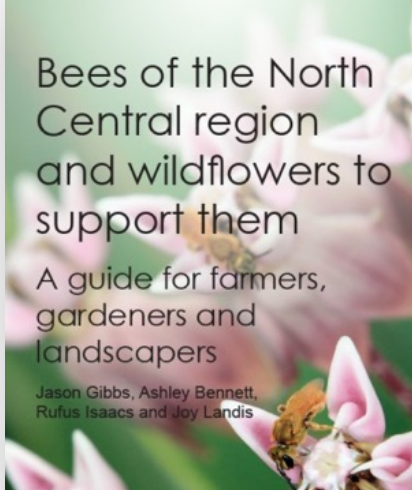
Many species of native bees are small and rarely collected. Taking some simple steps to enhance the farm environment for these beneficial insects will increase their abundance over time and can lead to more consistent crop pollination from year to year.

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Bees of the North Central region and wildflowers to support them

A guide for farmers, gardeners and landscapers

Jason Gibbs, Ashley Bennett, Rufus Isaacs and Joy Landis



Extension Bulletin E-3245 • New • May 2015

Minimizing Pesticide Risk to Bees in Fruit Crops

Emily Mae, Julianna Wilson and Rufus Isaacs
Department of Entomology, Michigan State University

SUMMARY

1. Bees are essential for pollination of many fruit crops.
2. Bees and other pollinators can be harmed by some pesticides used to manage insects, mites and diseases in fruit crops.
3. Growers can reduce pesticide risk to bees through these approaches:
 - Develop and implement a pest management plan with your beekeeper.
 - Use integrated pest management (IPM) to reduce the need for sprays.
 - Avoid pesticide sprays during crop bloom.
 - Apply pesticides after sunset or before sunrise, or when air temperatures is below 50°F.
 - Select the least toxic pesticides and formulations when possible.
 - Reduce drift onto areas outside crop fields.
 - Remove flowering weeds from crops.
 - Provide bee-friendly habitat away from crops.

INTRODUCTION

Pollinating insects, of which bees are the most important, contribute significantly to the yield and quality of fruit crops in the United States. Pollination services provided by bees are worth billions of dollars annually to fruit crop industries across the nation. Fruit crops vary in their need for bees to deliver pollen for pollination, but most – including apples, blueberries, cherries, strawberries and raspberries – will produce larger and more even fruit if their flowers are well visited by bees. For all these crops, having healthy bees to provide pollination is essential for their production, so protecting bees from pesticide risk is an important part of growing fruit crops.

This document provides information to help growers make informed decisions about how to minimize the risk of pesticides to bees. A list of insecticides and fungicides that are registered for use in the north-central region of the United States is provided in the back of the document.

Types of bees that provide pollination

Fruit growers are typically pollinated by a combination of wild and managed bees (Figure 1). More than 500 species of bees are present in the Midwest, and about 10 to 15 species are important contributors to the pollination of fruit crops.

WWW.POLLINATORS.MSU.EDU

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