Integrated Pest Management

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Integrated pest management (IPM) is the management of pest populations using a variety of practices. Pests are any organism that is detrimental to human activities. They include diseases, insects, vertebrates (ex: deer, birds, and moles), weeds, and nematodes. Crops provide food and shelter for many of these pests, and they will try their best to benefit from your hard work! IPM gives you the tools to make sure your harvests are successful.

We define IPM as pest *management* instead of control because total control over an outdoor environment is not our goal. The goal is low pest pressure, not no pest pressure. IPM practices try to strike a balance between cost of control measures and the benefit of retained crops. This is why we implement a multi-tiered approach illustrated in the pyramid above and detailed below to manage pest populations.

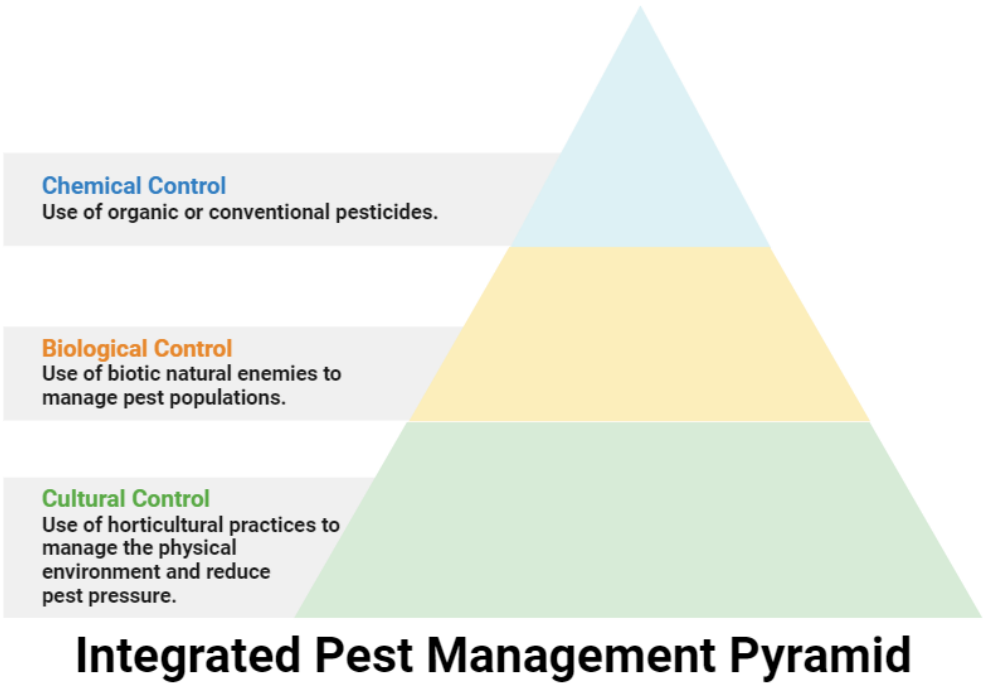

Figure 1. Integrated Pest Management Pyramid highlighting cultural, biological, and chemical control methods for managing pests. (Brown 2024, Created with biorender.com)

The *integrated* approach involves prioritizing cultural and biological practices to minimize our need for chemical inputs. When considering IPM strategies, start with manipulating the physical environment using **cultural control** methods (mowing, deer fencing, pruning and more) to set yourself up for success.

Next, consider how natural enemies of your pests can be supported and introduced to balance pest populations with **biological controls**. This can look like keeping a wildflower garden or releasing green lacewing eggs.

Finally, if pest populations continue to build, consider judicious use of **chemical controls** (either conventional or organic) to effectively reduce the pest populations.

How To Get Started

When planting crops, it is critical to think through IPM concerns from the start. Even when planting grass, we commonly cover the ground with straw to prevent birds from eating the seed! Early intervention prevents pest populations from expanding beyond the scope of your management. This early intervention is dependent on information input - knowledge is the most powerful tool in your IPM toolbox.

When starting to grow a crop, familiarize yourself with the common pests and diseases so that you can more readily identify and treat your issues. If you are unable to identify your pest, online resources like iNaturalist (https://www.inaturalist.org/) and PictureThis (https://www.picturethisai.com/) can help you quickly check a guess.

There are also statewide resources available online through Michigan State University (MSU)'s AskExtension (https://www.canr.msu.edu/outreach/ask-an-expert) and via mail with the Plant and Pest Diagnostics Laboratory (https://www.canr.msu.edu/pestid/). When directing your question to MSU experts, please include high quality pictures (close ups of issues, distance shots in context), details about the site history, management practices, and current issues.

Once you understand what pest is causing you problems, you can identify the best IPM solution for your situation! IPM is an iterative process and may require multiple strategies over time to manage the pest issue.

Section 1: Cultural Control

Cultural practices are the foundation of the IPM pyramid. When we talk about “cultural” in this context, we mean horticulture more than fine wine or opera! Pests use crops as their source of nutrients and/or shelter. If the growing environment can be adjusted to limit a pest’s access to these two factors, it will limit pest pressure before they get going! Some examples of cultural practices are below.

- Install deer fencing around your cultivated land to limit deer browsing.
- Plant disease free plant material and use disease free potting mix.
- Prune trees to open up the canopy. Fungal diseases prefer dark and humid environments!
- Healthy plants are less likely to become diseased. Consider your plant nutrition from the start.
- Tree guards can prevent rodent damage.
- Well-timed and consistent mowing and weed management.

Primary considerations

- Cultural control practices are proactive, not reactive. It is much easier to prevent pest issues than it is to fix issues!
- Cultural practices are year-round considerations. In orchard systems, winter pruning, summer mowing, and fall leaf mulching all contribute to lowering pest pressure.
- Familiarize yourself with the common pests and diseases associated with your crops and regularly check for them in your field. Set up a weekly scouting schedule throughout the season. Earlier interventions are easier!
    - Tip: MSUE Enviroweather (https://enviroweather.msu.edu/) has models that predict when pests and diseases will be active in your area based on local weather data.
- Identify what preventative strategies make sense for your cropping system.
    - Raised beds can use chicken wire to reduce herbivore browsing.
    - Research crop rotations prior to planting to limit disease/host compatibility.
    - If you are making compost, do not include weeds as compost piles may not reach high enough temperatures to denature seeds.
- Over time, you will identify your key IPM challenges. Refining your cultural practices to target these issues will help you continue to manage your pests.
    - For example, if Spotted Wing Drosophila is a major issue for your blueberries one year, you can install insect exclusion netting the next.
    - Another example is if you have a fungal leaf disease, consider flail mowing leaves in the fall and applying urea. This will increase decomposition and reduce disease pressure in the next year.

Process for getting started

Plant material selection - Selecting disease resistant plant material can reduce disease pressure over time. Disease resistance is never a guarantee, but it will have less disease pressure.

- Ensure that your plants are compatible.
    - Can those fruit trees cross-pollinate?
    - Are there black walnut trees near your garden? Black walnut toxicity may be a concern (https://hort.extension.wisc.edu/articles/black-walnut-toxicity/).
    - Do you have apple trees and cedar or juniper trees on your property? Cedar-Apple Rust may be a concern (https://ohioline.osu.edu/factsheet/plpath-tree-10).

- Ensure that your selected plants are non-invasive. Planting something like mint can be an irreversible decision!

Site selection - Ensure that your planting location has enough sunlight and drainage for the selected crop. Soil testing (https://homesoiltest.msu.edu/) with Michigan State University can set you up for success!

Identify steps to reducing pest pressure – As you begin, consider preventive measures you can utilize:

- Reduce weed pressure by solarizing soil (https://extension.umn.edu/planting-and-growing-guides/solarization-occultation).
- Limit vertebrate damage by installing fencing and tree guards.
- Keep pathogens in mind when deciding on plant spacing and placement. Pathogens thrive in dark, humid environments. Airy and light plantings are less likely to become diseased. Pruning, thinning, and less dense spacing can help!

Create a roadmap with seasonal goals - This can look like crop rotations throughout the year, winter pruning, spring fertilization, removing plant debris, and more! Identifying specific goals for each season will make cultural practices easier to keep up with.

Disclaimer: For a specific list of resources in the above description, view the Research & Recommendation Resources area of this section.

Common Questions for Cultural Control

1. How do I diagnose plant and pest issues in my planting?

It's important to make sure that you are familiar with the "usual suspects" that might affect your selected crop. If you are still stumped, reaching out to an expert in the field is a great next step. But there are a few key things to remember when sending someone samples/pictures in order for them to diagnose what is wrong with your crop.

- When it comes to pictures, generally sending more is better. It's always a good idea to include a picture of the mystery affliction up close, a whole picture of the affected plant, and a further away picture to give the diagnostician an idea of what the environment looks like.
- Take note of what plant parts are being impacted (leaves, fruit, bark, etc.). Identify where the issues are taking place (high or low, inside or outside of the canopy, all plants in an area or just a few).
- Reflect on whether the impacted areas have different physical environments (ei: field drainage, sunlight exposure, weed density, wood line proximity).

2. What are common cultural practices for my crop?

Different cropping systems require different IPM strategies, especially for cultural practices. Vegetable, nursery crops, field crops, and fruit all require unique approaches. Research your specific crop prior to starting!

- Vegetables (https://aggie-horticulture.tamu.edu/vegetable/guides/texas-vegetable-growers-handbook/chapter-iv-cultural-practices/)
- Nursery crops (https://nurserycrops.ces.ncsu.edu/cultural-practices/)
- Field crops (https://pivotandgrow.com/cultural-practices-to-give-the-crop-advantage/)
- Fruit crops (https://fruit.wisc.edu/2017/06/09/integrated-pest-management-cultural-controls/)

3. What if I already planted my crops? How do I start my IPM practices?

There is no time like the present! While it is easier to incorporate cultural management techniques from the start, it is certainly not required. Consider your IPM challenge areas and how incorporating an annual rotation of cultural management practices can help your crops today.

4. How do I choose which crops to plant and where to plant them?

Always get a soil test done prior to planning your cropping systems. This can give you information regarding any soil contamination (https://www.canr.msu.edu/news/testing-for-contaminants-in-soil-water-and-plants) like lead. Soil that has been exposed to old paint or historically used as a dumping ground is more likely to have heavy metal contamination.

Soil testing will also inform your soil amendment choices (https://extensiongardener.ces.ncsu.edu/2020/05/soil-testing-and-choices-of-amendments/). It is much easier to amend soil prior to planting crops - particularly perennials. While adding nutrients to the soil can be fairly straightforward, amending soil texture or pH is a much bigger undertaking. Plants have an ideal pH for gaining nutrients based on their adaptations. For example, blueberries thrive in low pH soils and asparagus thrive in high pH soils. It is often easier to align your crop choices with the texture and pH of your soils than fundamentally altering your available soil.

5. How do I scout?

Visual Inspection: Take representative, random samples of your cropping area. Be sure to visually inspect all levels of the canopy and both the interior and exterior of the canopy. Flip over leaves and inspect all plant parts. A good rule of thumb is 50 leaves/acre.

Pheromone Traps: Once you have identified common pests in your crops, you can use pheromone traps (https://npic.orst.edu/ingred/ptype/pheromone.html) to sample population levels. These traps consist of a reusable plastic shell, a replaceable sticky card that catches the insects, and a luring pheromone that is specific to the insect of interest. Check these traps on a weekly basis, keep track of population changes over time, and change pheromone lures on a monthly basis.

Action Thresholds: Each pest has an action threshold. This could range from 1 - 10 insects/trap/week. Once these thresholds are crossed, you can enact further IPM mitigation strategies. Visit: https://schoolipm.tamu.edu/forms/pest-management-plans/setting-action-thresholds/ for more information on setting action thresholds.

6. Where do I source my plants? What if I am looking for disease resistant varieties?

Look for reputable nurseries that have varieties you're looking for. In some cases, the supply of your desired trees or plants may be limited and you may have to wait up to a couple years for the nursery to stock them. Some nurseries will specialize in disease resistant or unique varieties of plants. Talk to other farmers about where they purchased their stock.

For field crop growers, check out the *Plant and Variety Selection section on Seeds*.

Go to *Plant and Variety Selection (Seeds)* section.

Research & Recommendation Resources

- MSU Soil Testing - https://homesoiltest.msu.edu/
- Soil Quality - https://extension.psu.edu/introduction-to-soils-soil-quality
- Soil Management - https://extension.psu.edu/introduction-to-soils-managing-soils
- Pheromone Traps - https://npic.orst.edu/ingred/ptype/pheromone.html
- Scouting
    - General: https://www.sare.org/publications/a-whole-farm-approach-to-managing-pests/taking-stock-the-basics-of-crop-scouting/?highlight=scouting
    - Row Crops: https://cropprotectionnetwork.org/web-books/crop-scouting-basics-for-corn-and-soybean?section=11-basic-guidelines-for-scouting#:~:text=The%20simplest%20scouting%20pattern%20is,different%20quadrants%20of%20the%20field.
    - Vegetable Crops: https://extension.psu.edu/scouting-for-pests-and-diseases-in-vegetable-crops
    - Fruit Crops: https://fff.hort.purdue.edu/article/scouting-101/
- Vegetable Crops - https://aggie-horticulture.tamu.edu/vegetable/guides/texas-vegetable-growers-handbook/chapter-iv-cultural-practices/
- Nursery Crops - https://nurserycrops.ces.ncsu.edu/cultural-practices/
- Row Crops - https://pivotandgrow.com/cultural-practices-to-give-the-crop-advantage/
- Fruit Crops - https://fruit.wisc.edu/2017/06/09/integrated-pest-management-cultural-controls/
- Solarizing Soil - https://extension.umn.edu/planting-and-growing-guides/solarization-occultation
- MSU Plant and Pest Diagnostics Lab - https://www.canr.msu.edu/pestid/
- MSUE AskExtension - https://www.canr.msu.edu/outreach/ask-an-expert
- PictureThis - https://www.picturethisai.com/
- iNaturalist - https://www.inaturalist.org/
- MSUE Enviroweather - https://enviroweather.msu.edu/

Industry Partners & Organizations

- Sustainable Agriculture Research and Education (SARE) - https://www.sare.org/sare-category/pest-management/cultural-control/

Section 2: Biological Control

When considering IPM strategies, it is important to think about how ecosystems function. Biological control is pest management with natural enemies (predators, parasitoids, and pathogens). After all, the enemy of my enemy is my friend! Natural enemies have evolved to specifically balance out the pest populations.

These natural enemies are often called “beneficials”, especially insects. However, we must take care that the beneficials we are encouraging do not become pests themselves! Successful biological control requires research and careful planning to succeed. Biological control includes a few different strategies to encourage beneficials. First, we can conserve existing populations with conservation strategies. We can also augment existing populations by introducing more natural enemies to the cropping system. Finally, classic biological control techniques involve establishing new populations of beneficials long term to control pests.

Biological control can be a double edged sword. When implemented correctly, it can drastically reduce pest populations in a region with limited environmental impacts and without pesticides! When used incorrectly, it can introduce invasive species to an area. Cane Toads in Australia and Asian Carp in the Mississippi River are classic examples of classic biological controls gone wrong. The USDA has very strict guidelines for implementing new species now. Successful biological control requires research before implementation!

Primary considerations

Conservation Biological Control **-** The first step of biological control is enhancing natural populations of beneficials. Just like we can reduce pests by limiting their access to food and shelter, we can promote beneficials by providing them with hospitable environments. There are many options for implementing this strategy.

- Plant a native flower field or strips adjacent to your crops.
- Use clover as a cover crop (Be sure to mow it prior to applying insecticides during crop pollination periods).
- Reduce insecticides that can target beneficial insects.

Augmentative Biological Control - If you are confident in a pest identification, you can research their primary biological controls. Many mass-reared beneficials are available online. They can be placed in a cropping system to temporarily boost beneficial populations.

- Typically, these are insect populations that will not establish in your area successfully.
- Keep in mind that an insect can be beneficial in one crop and a pest in another. Research across your crops prior to introducing anything.
- Lady bugs (scientifically known as lady beetles) are a beneficial insect in tree fruit and eat Woolly Apple Aphids. Lady bugs are also a pest in grape production and can easily contaminate juice!

Classic Biological Control - The classic model of biological control involves identifying a new invasive species that has no natural predators, researching its natural predators in its center of origin, and establishing those predators in the new environment after extensive testing. These two species can then keep each other in check.

- This is typically done by USDA and university cooperation. While established populations can reduce pest pressure for growers, they do not independently implement classic biological control.
- For example, MSU researchers are currently introducing Samba wasps to control the invasive Spotted Wing Drosophila in commercial fruit cropping systems. For more information on this research, visit: https://www.canr.msu.edu/news/msu-entomologists-welcome-arrival-of-samba-wasp-for-biocontrol-of-invasive-fruit-fly.

Process for getting started

Identify areas on your property that can be designated as beneficial habitats. This can support pollinators as well as parasitoids and predators!

- Would cover crops, prairie strips, or a wildflower meadow work best for you?
- Investigate the numerous funding resources available to support this at: https://pollinators.msu.edu/resources/growers/funding-opportunities-for-establishing-pollinator-habitat.aspx

Research your regularly used insecticides.

- Do they harm beneficial insects?
- Do you have less environmentally impactful or "softer" products available to you?

Research and be able to identify common pests and beneficials in your cropping systems.

- If you see a pest population increasing in your scouting, look into potential biological control options.

Disclaimer: For a specific list of resources in the above description, view the Research & Recommendation Resources area of this section.

Common Questions for Biological Control

1. *How do you identify "good" bugs?*

Research the common beneficial insects associated with your crops. Being able to identify their eggs and adult stages is very useful! The Natural Enemies Handbook is one of several excellent resources for this process.

2. *What kind of beneficials do I need?*

Apart from pollinators, beneficial organisms are highly specific to your crop selection. While we discuss beneficial insects most here, there are also beneficial microorganisms. For example, MSU is working to establish *Ovavesicula popilliae* populations, a fungus that grows in Japanese beetles' guts and kills them, in Michigan golf courses and fruit crops.

3. *How can you support beneficial populations?*

Plant cover crops and plants that attract beneficial insects (https://extension.psu.edu/attracting-beneficial-insects) adjacent to your crops. There are multiple grants available that will support your work to establish beneficial and pollinator habitats.

Research the impact that the chemical pesticides you would like to use have on beneficial insects. Select less impactful products when possible.

4. *What is an invasive species and how can I identify them?*

Invasive species are non-native organisms that do not have an existing check and balance system in their new ecosystem. As such, they can rapidly increase their populations with limited restrictions. The Midwest Invasive Species Information Network (https://www.misin.msu.edu/) has valuable information on what invasive species are in your area! Consider invasive species whenever you introduce organisms to the environment, whether they are your crop of choice or a biological control agent!

Research & Recommendation Resources

- Orchard Pesticide Effects on Natural Enemies Database - https://enhancedbc.tfrec.wsu.edu/opened/
- Funding opportunities for establishing pollinator habitat - https://pollinators.msu.edu/resources/growers/funding-opportunities-for-establishing-pollinator-habitat.aspx
- Attracting Beneficial Insects - https://extension.psu.edu/attracting-beneficial-insects
- Natural Enemies Handbook - https://ipm.ucanr.edu/IPMPROJECT/ADS/manual_naturalenemies.html
- Fruit Pest and Beneficial Search - https://www.canr.msu.edu/ipm/agriculture/fruit/search
- Vegetable Insect Guide - https://www.canr.msu.edu/resources/insect-guide-for-field-crops

Industry Partners & Organizations

- Michigan Agriculture Environmental Assurance Program (MAEAP) - https://www.michigan.gov/mdard/environment/maeap
- Midwest Invasive Species Information Network - https://www.misin.msu.edu/
- USDA Animal Plant Health Inspection Service - https://www.aphis.usda.gov/plant-pests-diseases/biocontrol
- Sustainable Agriculture Research and Education (SARE) - https://www.sare.org/what-we-do/

Section 3: Chemical Control

We often like to say “everything is a chemical,” but while true this statement isn’t always helpful. Here we are talking about interventions using either naturally derived or synthetically produced chemicals typically applied by spraying (but also potentially granules, dust, or other methods). A pesticide is any material that is applied to kill, attract, repel, or otherwise regulate pests.

Pesticides include disinfectants, fungicides, herbicides, repellents, and defoliants. We all use pesticides in our lives whether we’re cleaning a bathroom or preventing our dogs from getting fleas and ticks. They can be fast, effective, and easy to use. However, they can also be harmful to human health and the environment if used incorrectly.

Whether you are taking an organic or conventional approach to managing your crops, you will be using pesticides to manage pests. Consider how you will acquire and handle pesticides and how they can impact the environment in different ways.

Primary considerations

Pesticide Access - Pesticides are in one of two categories: Restricted Use and Unclassified.

- *Restricted Use* pesticides require a pesticide applicators license from MDARD to purchase and use. These products are tightly regulated and are more potentially hazardous to health and the environment.
- *Unclassified* products are available to the public and can be picked up ready-to-use at big box stores. They are generally less concentrated and less hazardous than restricted use products, but still require caution!

Pesticide Safety - You must fully read the label prior to using any pesticide. The label is the law and dictates pesticide use limits and safety concerns. Best practices often required by the label include:

- Wear the recommended personal protective equipment (PPE). The baseline PPE is gloves, goggles, and long sleeve shirts.
- Wash your hands after handling pesticides!
- Hazard = Toxicity x Exposure - When using a product, we cannot change its toxicity. However, we can take reasonable precautions to limit exposure.

Process for getting started

Learn how to read pesticide labels (https://npic.orst.edu/health/readlabel.html) before you get started with restricted use or unclassified pesticides. The label is the law! It has information that can help you effectively protect yourself and make the most effective pesticide applications possible. It can also be dense and confusing at first.

Review safe use practices (https://npic.orst.edu/health/safeuse.html) to minimize your personal and environmental risk prior to making any applications.

Identify what spray equipment is right for your cropping system. Whether you use a backpack sprayer (https://extension.usu.edu/crops/research/backpack-and-canister-sprayers) or an air blast sprayer (https://treefruit.wsu.edu/web-article/six-steps-to-calibrate-and-optimize-airblast-sprayers/), learn how to operate and calibrate your equipment before use.

Establish a record keeping system for your spray conditions, product use, and impact on pest populations. This is both legally required for restricted use pesticide applications and very helpful for evaluating spray program efficacy.

The Michigan Department of Agriculture & Rural Development (MDARD) handles pesticide certification within Michigan. If you are interested in using restricted use pesticides, they have resources for training and certification. For more information, visit: https://www.michigan.gov/mdard/licensing/pesticide

Michigan State University also has a Pesticide Safety and Education Program (PSEP) that can provide resources. For more information, visit: https://www.canr.msu.edu/psep/

Disclaimer: For a specific list of resources in the above description, view the Research & Recommendation Resources area of this section.

Pesticide Terminology

There are a number of common terms to be familiar with when considering chemical control options.

Mode of Action describes how pesticides work to control a pest(s). *Systemic* pesticides are absorbed through tissues and transported elsewhere where the pest encounters it or through feeding. *Contact* pesticides must come in direct contact with the target pest.

Selectivity describes what range of pests a given product can affect. *Non-selective* products kill all related pests. Some herbicides kill all green plants that get a sufficient dose. *Selective* products kill only certain weeds, insects, and plant pathogens. Other herbicides only kill broadleaf weeds, but not grasses.

Persistence describes How long a product can remain active in the environment depends on if they are residual or non-residual. *Residual* pesticides can remain active for weeks to years. Herbicides used around road guard rails have a long residual effect. *Non-Residual* pesticides are inactivated immediately or within a few days after application. Some herbicides do not remain active in the soil once applied.

Persistence also impacts the Reentry Interval (REI) and Preharvest Interval (PHI). These periods can be hours or days long depending on the label. *Reentry Interval (REI):* How long you must remain out of a pesticide treated area post application without proper PPE. *Preharvest Interval (PHI):* How far ahead of the harvest date you can legally apply pesticides.

Common Questions for Chemical Control

1. How do you become a certified applicator?

MDARD handles pesticide applicator certification in Michigan. Generally, you study and take a commercial or private test and a specialized test based on your crop. This certification lasts for three years. You can gain recertification credits to indicate that you are getting continued education from MSUE events. Alternatively, you can retake the tests every three years. For more information, visit: https://www.michigan.gov/mdard

2. How do you buy pesticides?

You can purchase unclassified pesticides online or at big box stores like Lowes, Home Depot, or Tractor Supply Company. Michigan currently has 242 restricted use pesticide dealers according to MDARD (https://www.michigan.gov/mdard/licensing/pesticide/rup). Contact a local supplier for more information.

3. *How do you read a label?*

Fully reading the label prior to use is essential for safe and legal pesticide handling. There are multiple resources available, including these from the National Pesticide Information Center (https://npic.orst.edu/health/readlabel.html) and the EPA (https://pesticidestewardship.org/homeowner/how-to-read-the-label/), that breakdown the important components of the label and what they mean. Keep in mind that labels change over time and reading is required to keep up on these changes.

4. *How do I know when/what to spray?*

Pesticide applications should be made based on scouting as well as plant growth stages. Plant diseases have to be managed proactively. As such, fungicides and bactericides are often applied based on past disease symptoms, current plant growth stages, and predicted weather conditions for the week. For example, if you have had apple scab in your apple trees in the past, you know that spores are still discharging in the spring, and it will be a wet week with great infection conditions, then you should apply preventative sprays. However, insecticide applications are based on action thresholds and your scouting. If a pest population is increasing and you do not have a biological control solution available to you, then it is time to spray insecticides.

You should also consider pesticide resistance. You should research which pests have developed resistance to which products in your area. Keeping up to date with MSU product recommendations will help! Applying pesticides to pests that have partial or full resistance can make the resistance issue worse without adequate control of the pest population. For more information, visit: https://pesticidestewardship.org/resistance/understanding-resistance/

Finally, take pesticide selectivity into consideration. We generally have broad spectrum pesticides and narrow spectrum pesticides. Broad spectrum pesticides will interact with multiple organisms where narrow spectrum pesticides have specific pests they can harm. There is an ongoing debate about which ones are better for the environment. On the one hand, broad spectrum pesticides are much more likely to interact with non-target organisms and impact the local environment than more selective products. On the other hand, they require fewer applications of pesticides (saving time, money, and product) and are less likely to develop resistance issues over time than selective pesticides. It is up to you to decide which of these arguments matters more to you and your management practices.

5. *What kind of equipment do I need?*

This is highly dependent on your scale of production! If you are a small scale producer, you can use a backpack sprayer, which can be hand pumped, or battery powered. As you scale up, the options become increasingly diverse (https://www.uky.edu/Ag/Entomology/PSEP/14appequip1.html). You can look into purchasing spray equipment second hand from other local growers to make a more cost effective choice while your operation grows! Your pesticide applications are only as good as your equipment and product choice.

Research & Recommendation Resources

- MSU IPM Hub - https://www.canr.msu.edu/ipm/
- MSU IPM Academy - https://www.canr.msu.edu/courses/integrated-pest-management-academy
- MDARD Restricted Use Pesticide Dealers - https://www.michigan.gov/mdard/licensing/pesticide/rup
- Pesticide Label Reading - https://pesticidestewardship.org/homeowner/how-to-read-the-label/ and https://npic.orst.edu/health/readlabel.html
- Sprayer Calibration - https://treefruit.wsu.edu/web-article/six-steps-to-calibrate-and-optimize-airblast-sprayers/ and https://extension.usu.edu/crops/research/backpack-and-canister-sprayers
- Bulletins Live! Two - https://www.canr.msu.edu/blt/
- Pesticide Terminology - https://sor.epa.gov/sor_internet/registry/termreg/searchandretrieve/glossariesandkeywordlists/search.do?details=&glossaryName=Pesticides%20Glossary

Industry Partners & Organizations

- Michigan Department of Agriculture & Rural Development (MDARD) - https://www.michigan.gov/mdard
- Pesticide Educational Resource Collaborative - https://www.pesticideresources.org/wps/
- IR-4 - https://www.ir4project.org/
- Pesticide Safety and Education Program - https://www.canr.msu.edu/psep/
- National Pesticide Information Center - https://npic.orst.edu/
- Poison Control - https://www.poison.org/