Intro to Integrated Pest Management

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Maui County Cooperative Extension

COOPERATIVE EXTENSION
UNIVERSITY OF HAWAIʻI AT MĀNOA
COLLEGE OF TROPICAL AGRICULTURE AND HUMAN RESOURCES

What is a pest?

- An annoying person or thing; a nuisance

What is a pest?

A destructive insect or other animal that attacks crops, food, livestock, etc.

Plants or animals detrimental to humans or human concerns (agriculture or livestock production)

- Includes insects, animals and plant diseases that predate upon or otherwise cause damage to plants

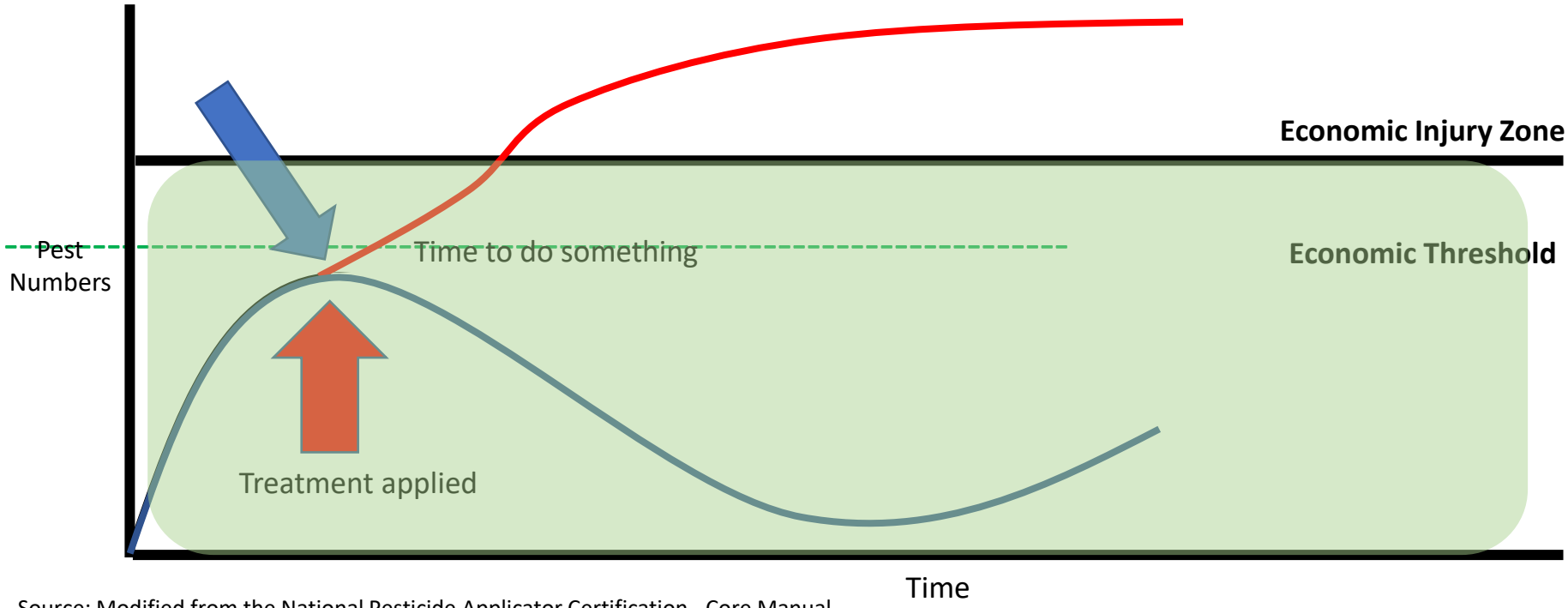
Photo: Scot Nelson

Integrated Pest Management

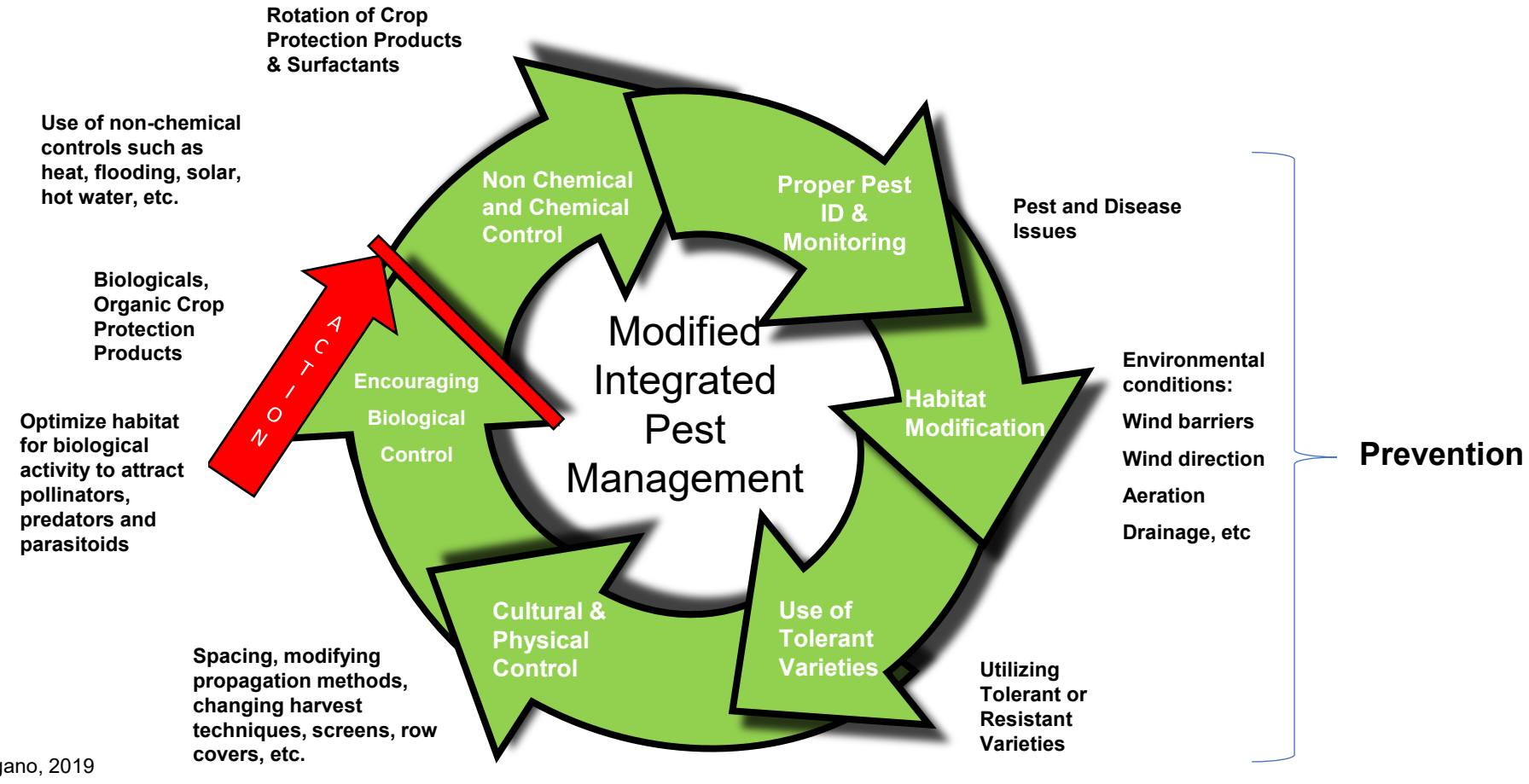
- The use of **all possible pest control methods** in a well organized and harmonious way in order to achieve long term pest control
- Maintain or improve production without negatively impacting the environment and human health and safety

- IPM is an ecosystem-based strategy that focuses on **long-term** prevention of pests or their damage through a combination of techniques

Integrated Pest Management (IPM)

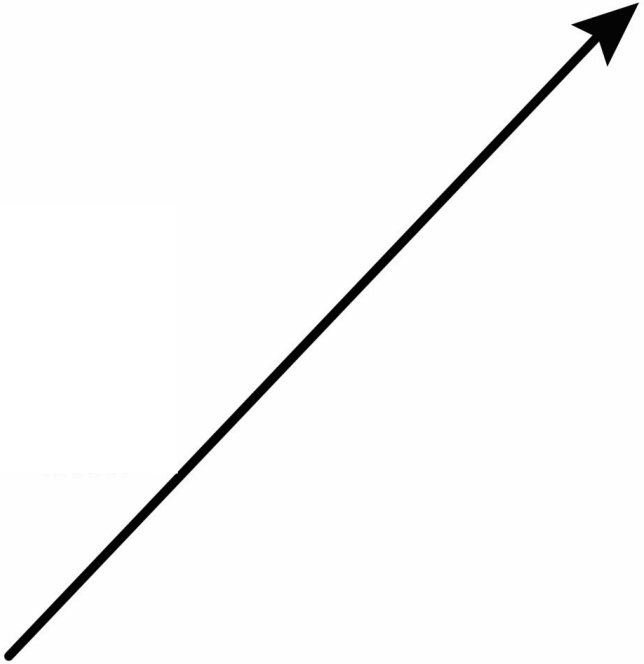


Source: Modified from the National Pesticide Applicator Certification - Core Manual.


Rotation of Crop Protection Products & Surfactants
Use of non-chemical controls such as heat, flooding, solar, hot water, etc.
Biologicals, Organic Crop Protection Products
Optimize habitat for biological activity to attract pollinators, predators and parasitoids
Spacing, modifying propagation methods, changing harvest techniques, screens, row covers, etc.
Utilizing Tolerant or Resistant Varieties
Pest and Disease Issues
Environmental conditions:
Wind barriers
Wind direction
Aeration
Drainage, etc
Prevention
Modified Integrated Pest Management
Non Chemical and Chemical Control
Proper Pest ID & Monitoring
Habitat Modification
Use of Tolerant Varieties
Cultural & Physical Control
Encouraging Biological Control
ACTION

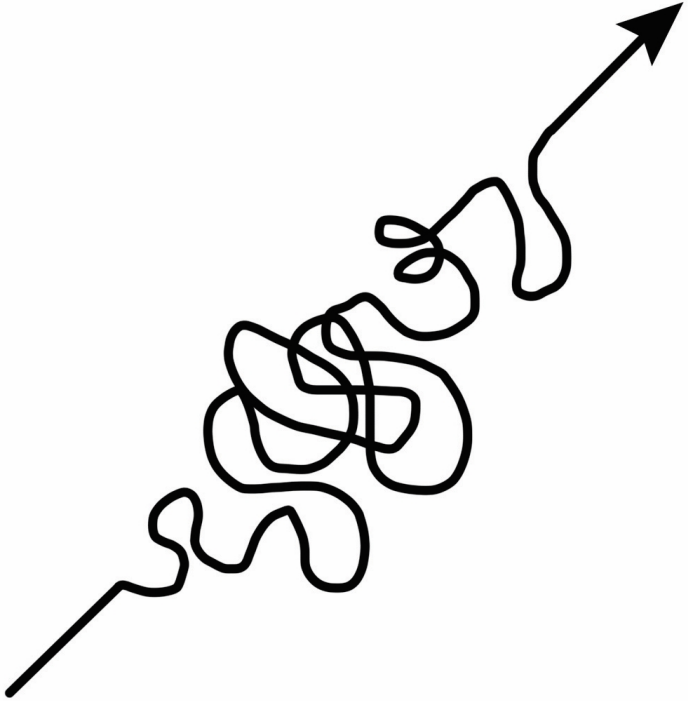
Sugano, 2019

SUCCESS



what people think
it looks like

SUCCESS



what it really
looks like

Pest ID and Monitoring

Rosemary Gutierrez-Coarite

Pest Identification

- To effectively control a pest, it is important to accurately identify it.
- Pests can easily be mistaken for non-pests (beneficial bug), and vice versa.
- There are many identification guides online, consider information from universities or government agencies.
- Field guides and other printed references may be available at our Cooperative Extension Office.

https://www3.epa.gov/region1/eco/uep/pdfs/BugBook.pdf

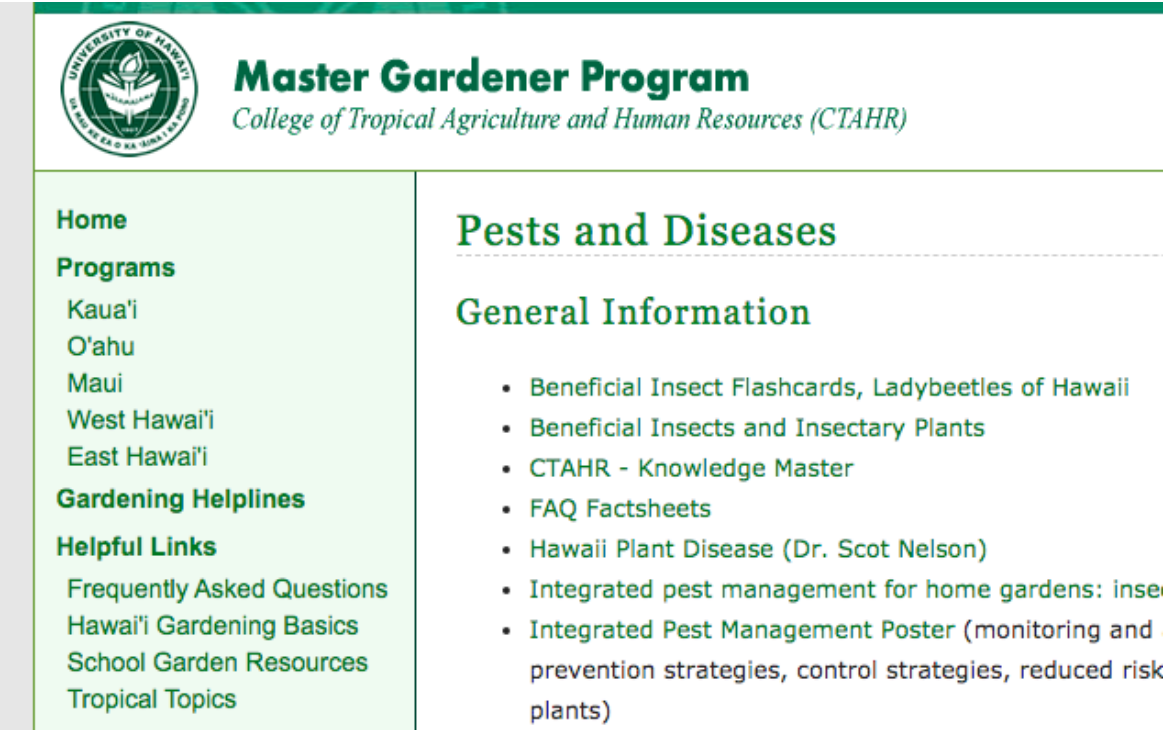
Examples

https://www.growveg.com/pests/us-and-canada/

https://www.growveg.com/pests/us-and-canada/

No always accurate,
some pest are not present in Hawaii

Look for Local Information



Master Gardener Program

College of Tropical Agriculture and Human Resources (CTAHR)

Home

Programs

- Kaua'i
- O'ahu
- Maui
- West Hawai'i
- East Hawai'i

Gardening Helplines

Helpful Links

- Frequently Asked Questions
- Hawai'i Gardening Basics
- School Garden Resources
- Tropical Topics

Pests and Diseases

General Information

- Beneficial Insect Flashcards, Ladybeetles of Hawaii
- Beneficial Insects and Insectary Plants
- CTAHR - Knowledge Master
- FAQ Factsheets
- Hawaii Plant Disease (Dr. Scot Nelson)
- Integrated pest management for home gardens: inse
- Integrated Pest Management Poster (monitoring and prevention strategies, control strategies, reduced risk plants)

https://www.ctahr.hawaii.edu/UHMG/

How to identify a pest?

- Proper identification and understanding the nature of the pest are the key steps in selecting the best pest management strategy.
- Usually done with descriptions of the bug, damage done, and the type of plant injured.
- E.g. diamondback moth

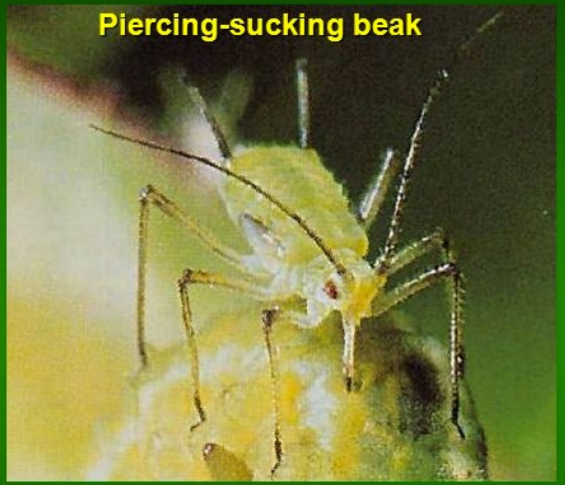

Photo: Lyle Buss, University of Florida


Photo: Dan McGrath


Photo: Varela icipe

- Any type of information like this can help you with pest identification.
- If you actually spot the bugs, you can search for their primary characteristics (caterpillar, worm, beetle, moth, scales, etc.)

INSECT MOUTHPARTS



Plant damage results from feeding, which depends on the type of mouthparts

Photos: Alexsandre Latchininsky

Common Pests

Chewing pests

- Chewing pest feed on the foliage, stems, fruit or roots.
- Pests within this group include beetles, caterpillars, earwigs, leaf miners, etc.

http://www.gardenguyhawaii.com

https://citybugs.tamu.edu/factsheets/landscape/chewing

Common Pests

- **Sucking pests**
- These pest pierce plant's vascular tissue and suck plant sap.
- They cause plants to discolor, twist and distort.
- Pests within this group include aphids, whiteflies, mealy bugs, scales and leaf
- hoppers.
- Aphids

https://www.amazingherbgarden.com/how-to-get-rid-of-aphids-in-our-herb-garden

https://www.alamy.com/stock-photo/aphid-damage

Common Pests

- **Whiteflies** vectors of diseases

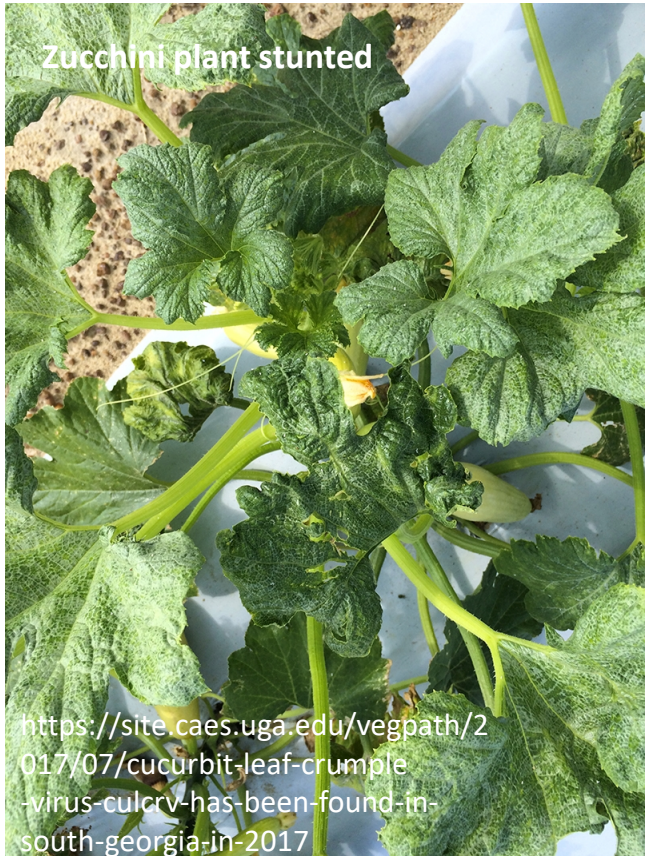
https://plantdoctor.co.nz/problem-finder/whitefly

https://extension.illinois.edu/blogs/good-growing/2020-05-01-troubles-tomatoes

Tomato Yellow Leaf Curl virus

https://www.greenlife.co.ke/tomato-yellow-leaf-curl-virus-2/

Zucchini Silver Leaf virus



Zucchini plant stunted

https://site.caes.uga.edu/vegpath/2017/07/cucurbit-leaf-crumple-virus-culcrv-has-been-found-in-south-georgia-in-2017

Common Pests

Mealybugs

https://www.alamy.com/stock-photo-australia-longtailed-mealybug-19107763

https://iapps2010.me/2015/05/04/iita-requests-usd-200000-from-un-fao-to-contain-papaya-mealybug

Common Pests

Scales

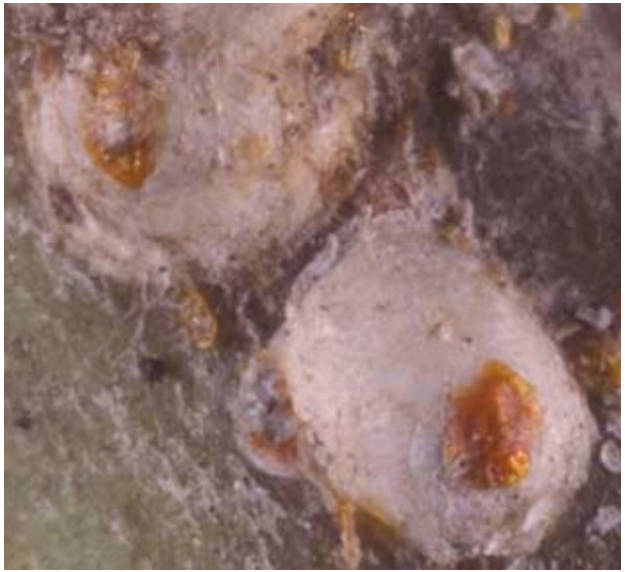


Photo: Lyle J. Buss, University of Florida

http://www.extento.hawaii.edu/kbase/crop/crops/whitepeachscale

Common Pests

Thrips

https://entomology.ca.uky.edu

http://cues.cfans.umn.edu/old/inter/inmine/Thripk

http://nault.entomology.cornell.edu/extension/onion-thrips-in-onion

Common pests

Fruit flies

Oriental fruit fly

http://www.latinoreport.com/sacramento-could-have-issues-with-invasive-oriental-fruit-flies-again/

http://uccemg.com/files/174233.pdf

Melon fly

https://www.asean-agrifood.org

https://www.infonet-biovision.org/PlantHealth/Pests/Fruit-flies

Nematodes

- Roundworms that attack the root system of plants and impair water and nutrient uptake.
- Symptoms: stunting, poor plant growth, narrow and weak stems, foliar chlorosis, root rotting and galling, plant toppling and poor root development.

http://soilquality.org.au/factsheets/nematodes-nsw

https://www.ipmimages.org/browse/detail.cfm?imgnum=1436056

https://www.agric.wa.gov.au/capsicums-and-chillies/root-knot-nematodes-western-australia

Slugs and Snails

- Slugs and snail are problem for low-growing vegetables.
- They are active in the evenings.
- Carriers of rat lungworm disease that affects the brain and spinal cord.

http://www.honolulumagazine.com/Honolulu-Magazine/April-2017/6-Things-You-Need-to-Know-About-Rat-Lungworm-Disease-Before-You-Eat-a-Salad

https://www.newsweek.com/cdc-rat-lungworm-cases-confirmed-hawaii-after-visitors-ate-slug-salad

https://www.corrys.com/resources/slugs-and-snails-all-you-need-to-know

https://www.theadvocate.com/baton_rouge/entertainment_life/homegarden

Common Diseases

Fungal Pathogens

- Common plant disease composted of threadlike structures called hyphae. Reproduce and disperse by spores. Common fungal pathogen include: powdery mildew, downy mildew, Alternaria, Cercospora, Phytophthora, etc.

https://bigbloomhydro.wordpress.com/tag/powdery-mildew

Photo: Matthew Orwat

https://soybeanresearchinfo.com/soybean-disease/phytophthora-root-stem-rot

Viral Pathogens

- They can only survive on living plant tissue.
- Once infected there is no cure.
- They are mainly transmitted by insect vectors.
- Common plant viruses include: Banana Bunch Top Virus, Tomato Spotted Wilt

https://www.flickr.com/photos/scotnelson/23882565597

https://en.wikipedia.org/wiki/Banana_bunchy_top_virus

Bacterial Pathogens

- Bacterial pathogens reproduce quickly and form masses called colonies. They are spread primarily via rain, or splashing water. They often enter plant tissue through natural openings or injury sites. Examples include: Xanthamonous, Pseudomonas, Erwinia, etc.

https://www.alamy.com/bacterial-blight-xanthomonas-campestris-infection-on-a-tomato-leaf-thailand-image282773942

https://gardenerspath.com/how-to/disease-and-pests/turnip-bacterial-leaf-spot/

https://extension.umn.edu/diseases/bacterial-wilt

Pest Monitoring

- To assess the pest situation and determine what sort of pest activity is occurring
- For decision making
- To predict pest problems before they occur

The decision to use a pesticide should be based on:

- Information obtained from monitoring
- Knowledge of thresholds
- An awareness of potential benefits and risks associated with a treatment

Monitoring methods

Types of monitoring methods

- Visual Counts
- Pheromone traps
- Sweep Nets
- Field Histroy




https://www.slideshare.net/AhmedSyedUsman/ipm-of-forest-insect-pests

Examples

- **Melon fruit fly**

http://www.cdfa.ca.gov/plant/PDEP/targetpestdiseaseprofiles/melonfflprofile

Trap with Torula yeast lure

Photo: R. Shimabuku

Examples

Cabbage aphid

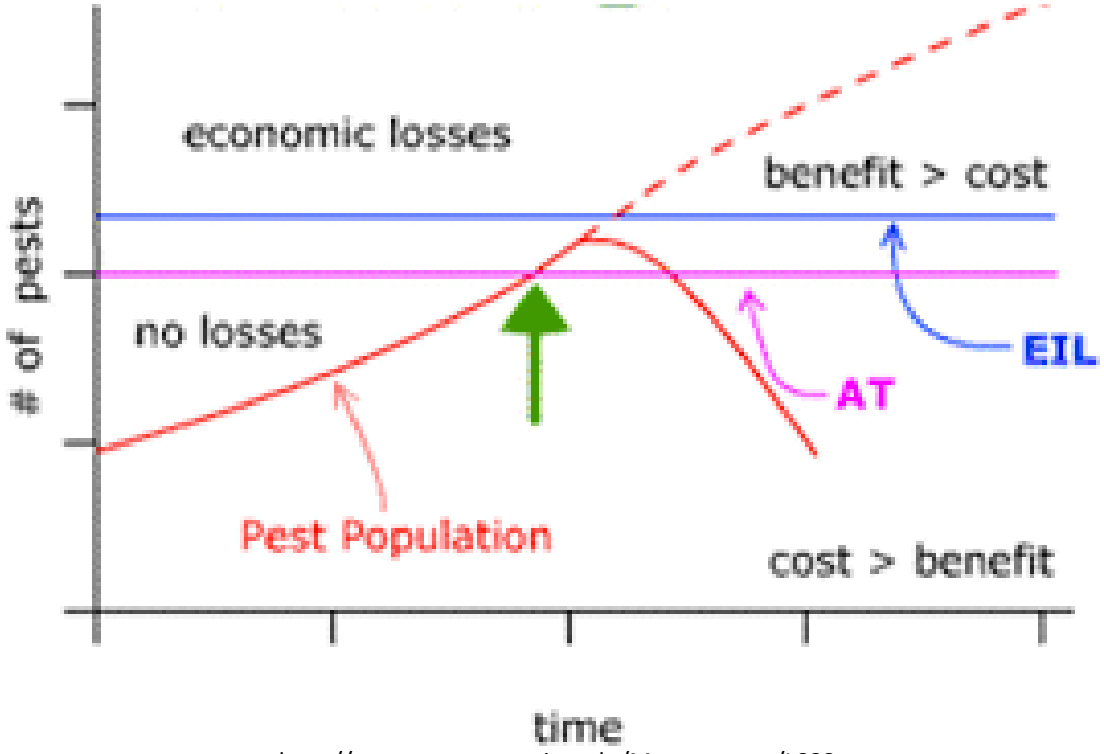
- Scout weekly, starting before harvested portions of the crop begin to develop.

https://ag.umass.edu/vegetable/fact-sheets/aphid-cabbage

https://www.agric.wa.gov.au/autumn/cabbage-and-turnip-aphids-cabbage-pests-indonesia-and-western-australia

Action Threshold

Apply a control method



http://corn.agronomy.wisc.edu/Management/L023

Example

Cabbage aphid

- Treat when >10% of plants have at least 1 aphid, or scout 10 leaves at 10 sites for 100 leaves per field and treat if >20% have aphids.

https://www.alamy.com/stock-photo/cabbage-aphid

Example

Photo: Dr. Arnold H. Hara, CTAHR

https://european-seed.com/2018/02/thrips-know-onions/p1040415-chris-wallwork-agrii-onion-thrips-thrips-tabaci

Onion Thrips

- Count 10 plants per site.
- Threshold = 100 thrips in less than 10 plants are inspected.
- If monitoring finds a total of 100 thrips after only four plants are counted, the decision would be to spray.
- If monitoring finds a total of 90 thrips after 10 plants are inspected, the decision would be not to spray, because the action threshold of an average of 10 thrips per plant was not exceeded.
- Thrips transmit Iris Yellow Spot Virus

https://utahpests.usu.edu/ipm/notes_ag/veg-iris-yellow-spot-virus

Habitat Modification

Rosemary Gutierrez-Coarite

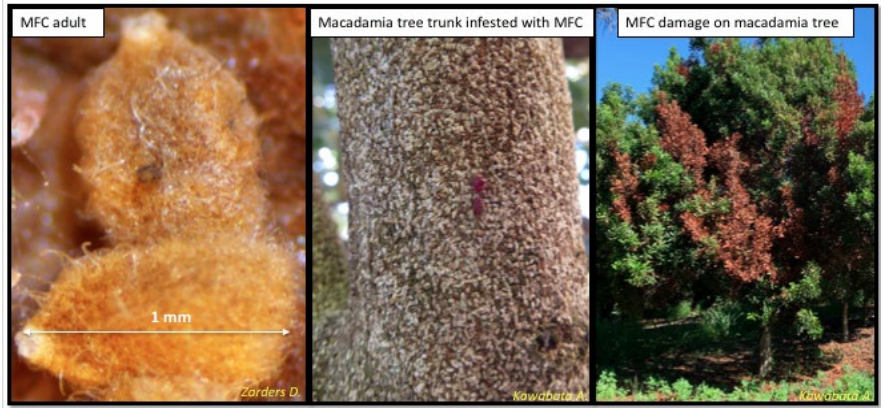
Habitat Modification

- Eliminate pests breeding sites.
- Eliminate favorable conditions such as pest / disease build up, removal of food or habitat sources, sanitation of fields and adjacent areas.
- Attracts beneficial insects.

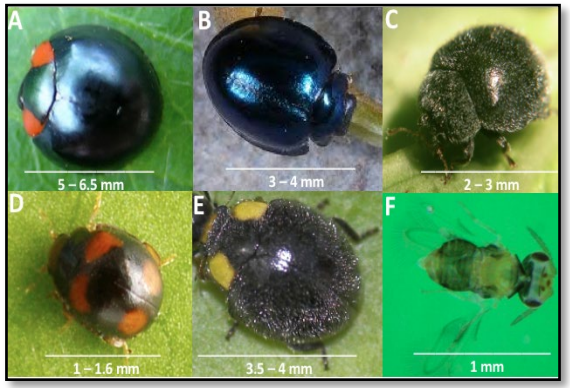
https://content.ces.ncsu.edu/extension-gardener-handbook/19-landscape-design

https://www.tenthacrefarm.com/transitioning-to-a-no-till-garden

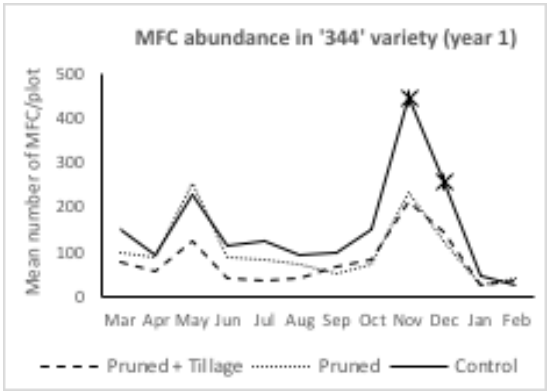
Example: Macadamia Felted Coccid



Photos : A. Kawabata and R. Gutierrez-Coarite



http://www.tropicalbytes.co.za/wp-content/uploads/2019/10/Macadamia-Felted-Coccid_description-monitoring-and-control

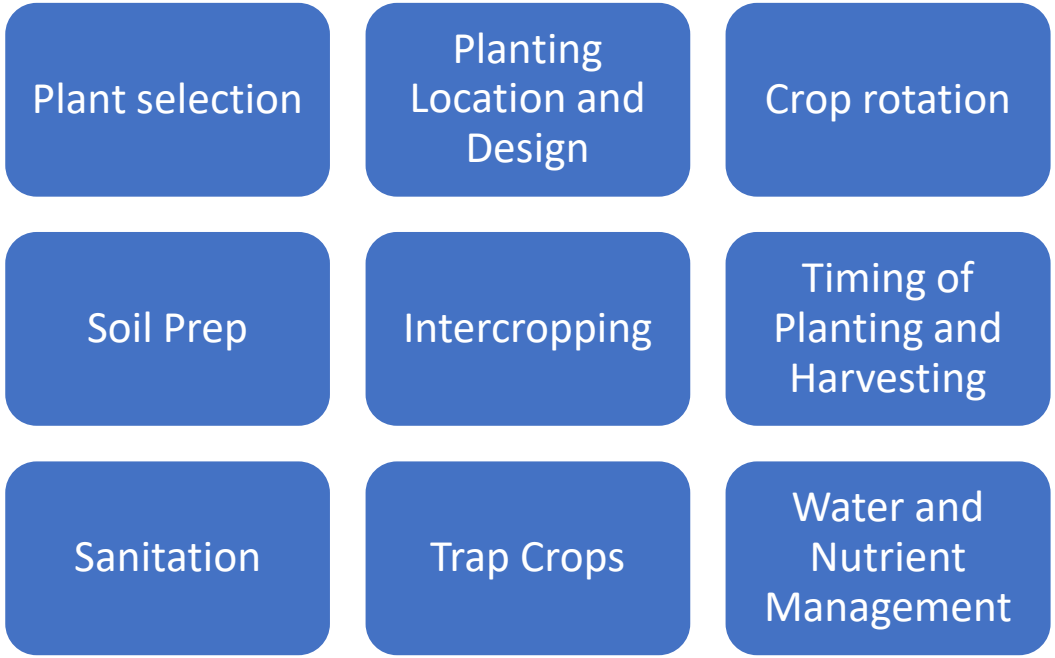


Cultural Control

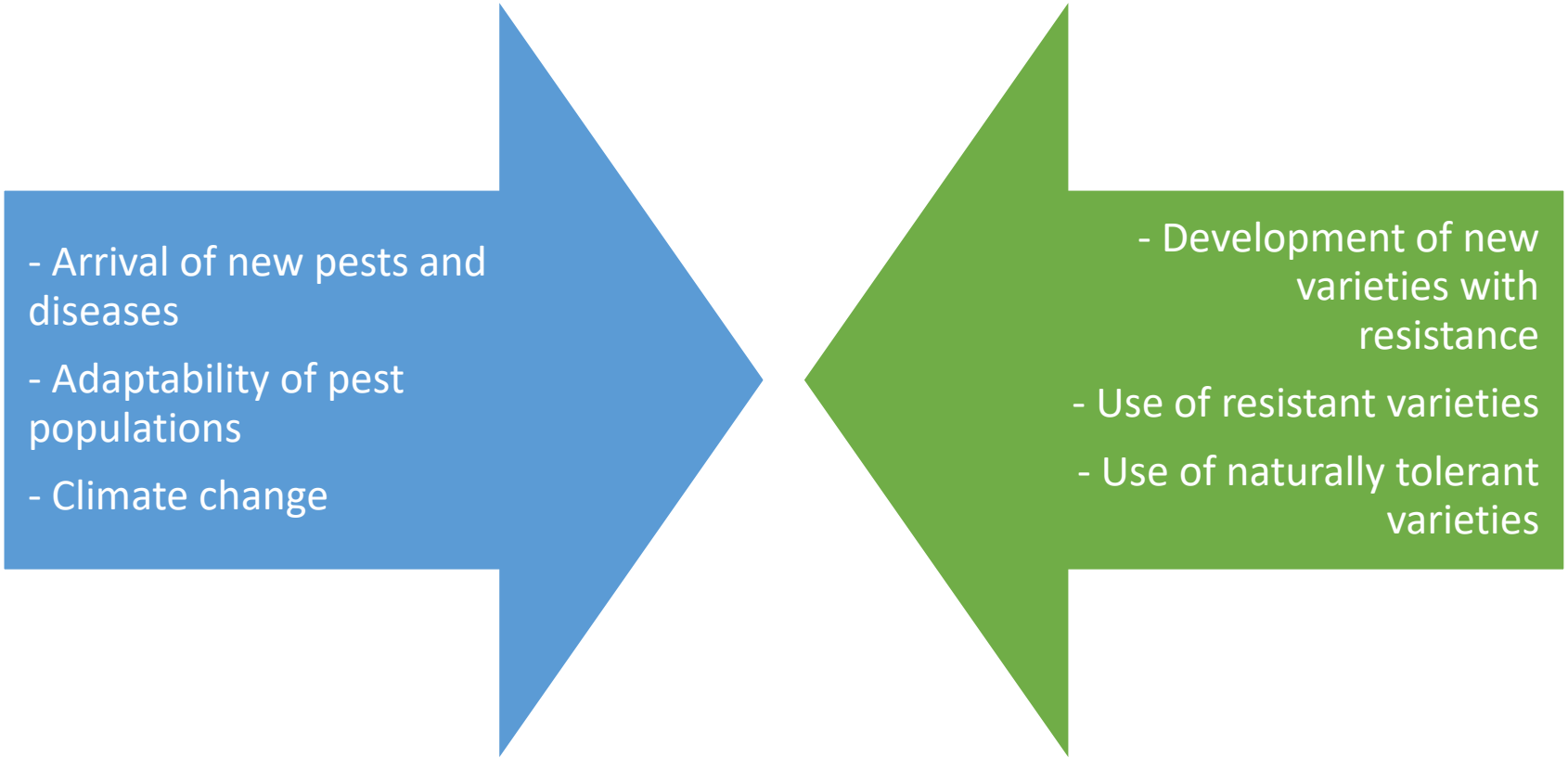
Kylie Tavares

Cultural Control

- Practices to discourage pest establishment, reproduction, dispersal, and survival
- Prevention and avoidance
- Methods can be effective, cost-efficient, and present little risk to people and environment
- Consider planning, labor, space/land



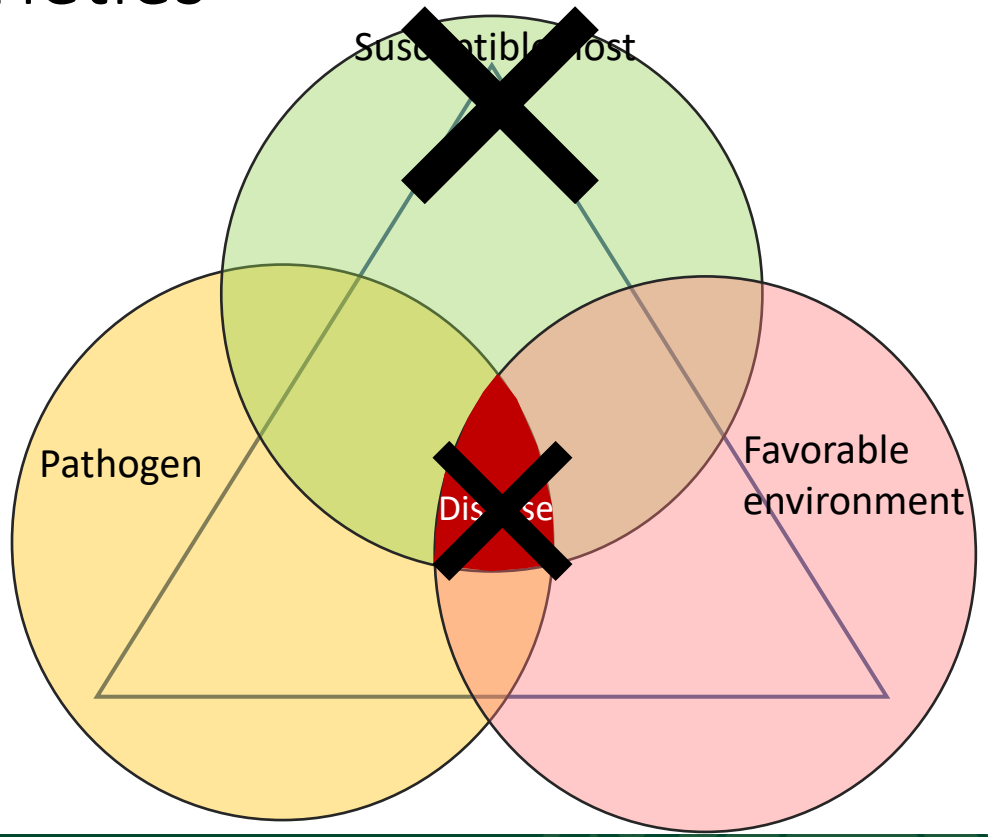
Plant Selection: Using Resistant/Tolerant Plants



Using Resistant Varieties

Break the disease triangle!

- Use certified seed (free from pathogens and weeds)
- Using resistant varieties can help other IPM efforts (not a silver bullet)



Soil Prep

- Know and understand the field history
- Maintain and/or build soil health by promoting soil biodiversity
- Build soil organic matter
- Reduce soil disturbance

Photos: Scot Nelson, Koon-Hui Wang

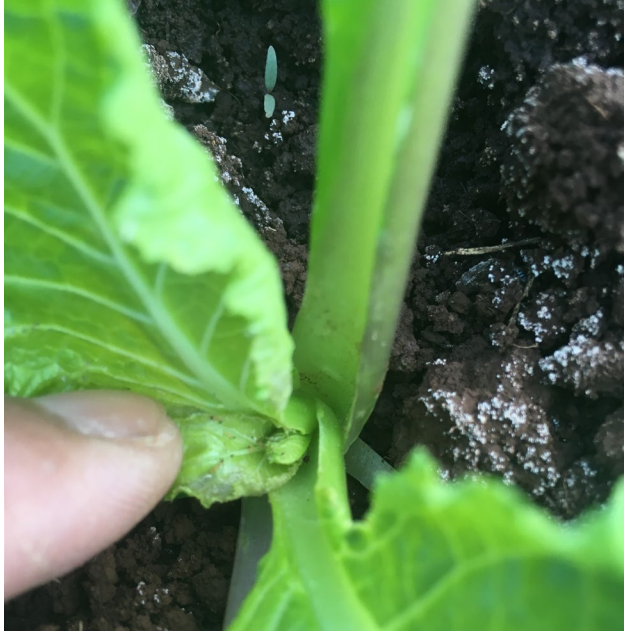




Photo: J. Sugano

Clean and Healthy Start

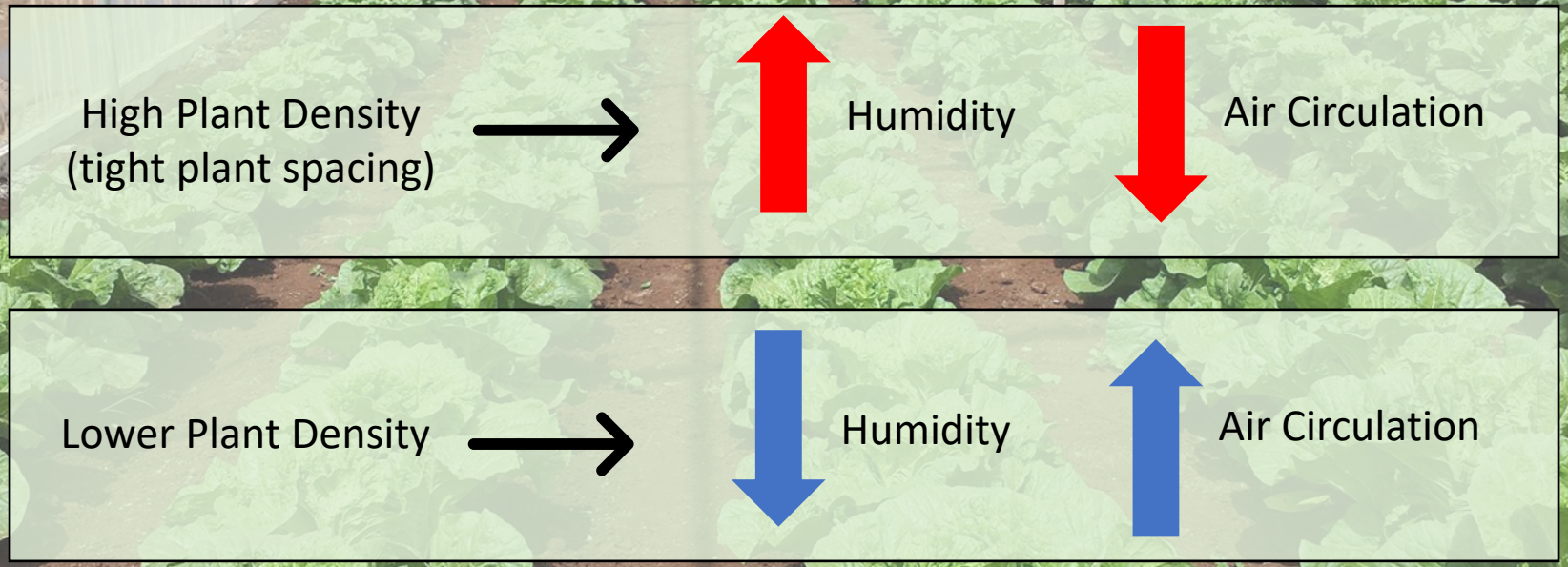
- Pest-free, healthy transplants/propagative material
- Pre-plant sanitization or heat treatment
- Clean, pest and disease-free seeds (certified seed)

Timing Planting and Harvesting

- Understand life cycles and patterns of key pests
- Plan crop rotation around pest cycles
  - Ex. Bagrada bug
- Time harvests to minimize pest damage
  - Ex. Fruit fly

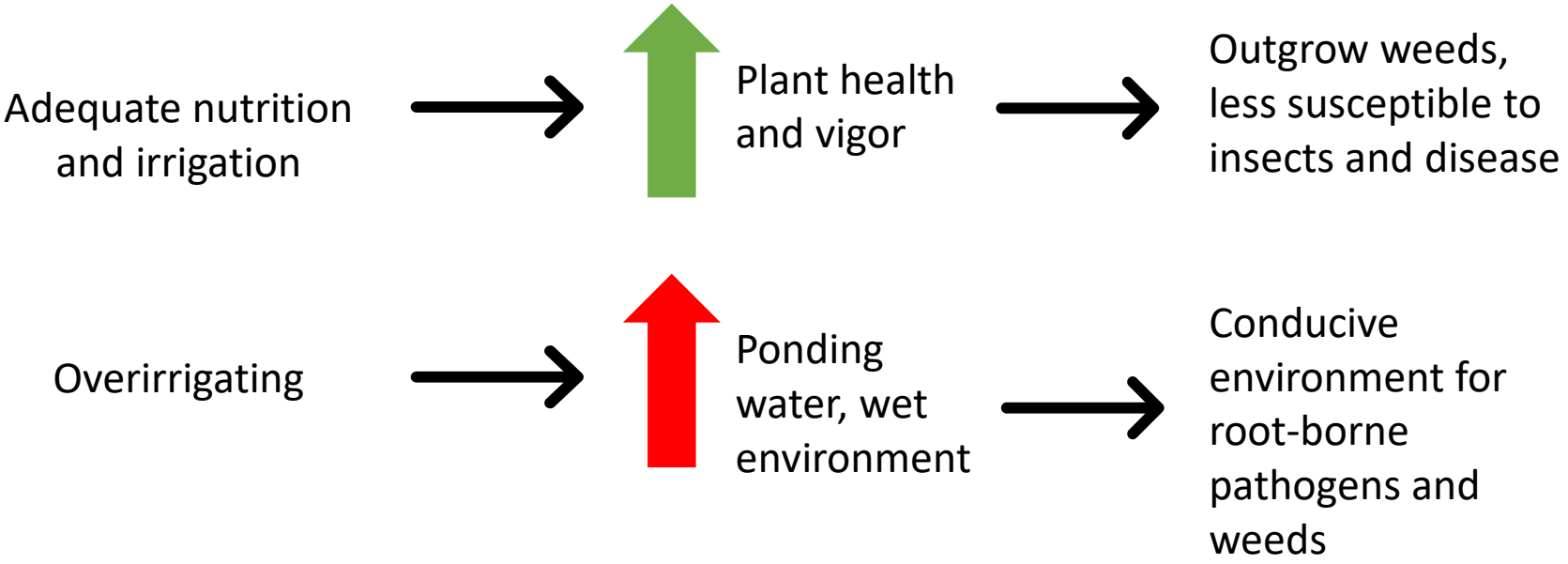
Photo: Scot Nelson

Proper Plant Spacing



Follow recommendations for crop spacing

Nutrient and Irrigation Management



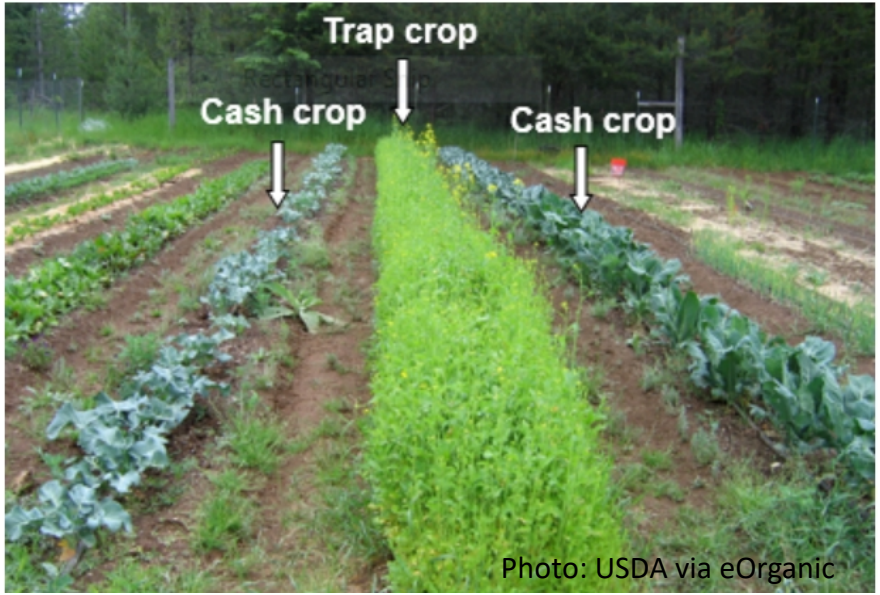
Crop Rotation

- Break pest cycles
- Diversify, avoid monocultures
- Incorporate cover crops, legume crops
- Don’t follow a crop with a closely related species/crop
- Don’t follow a crop with another that is susceptible to the same pest

Intercropping

- Growing different crops together in the same field
  - Ex. In the same row, alternating rows
- Adds crop diversity
- Can also intercrop with insectary plants to attract natural enemies

Photo: Koon Hui-Wang



Trap Crops

- Grown to protect cash crop away to lure pests away
- Trap crops are more attractive to target pests
- Pest can be managed on the trap crop
- Often planted around perimeters

Field Sanitation

- Eliminates breeding areas for insect pests
  - Removal of old, fallen fruit (ex. Fruit fly, coffee berry borer)
- Removes and minimizes plant pathogen inoculum
  - Tool sanitation
  - Avoid working fields when wet
  - Removal of infected plants and plant parts

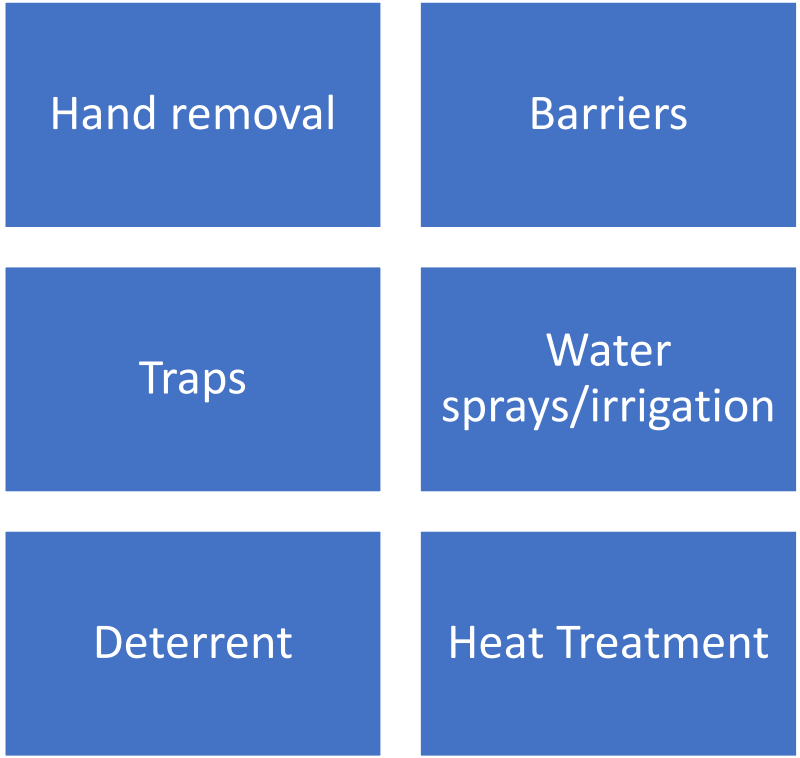
Photos: J. Sugano, S. Nelson

Mechanical and Physical Control

Kylie Tavares

Mechanical and Physical Control

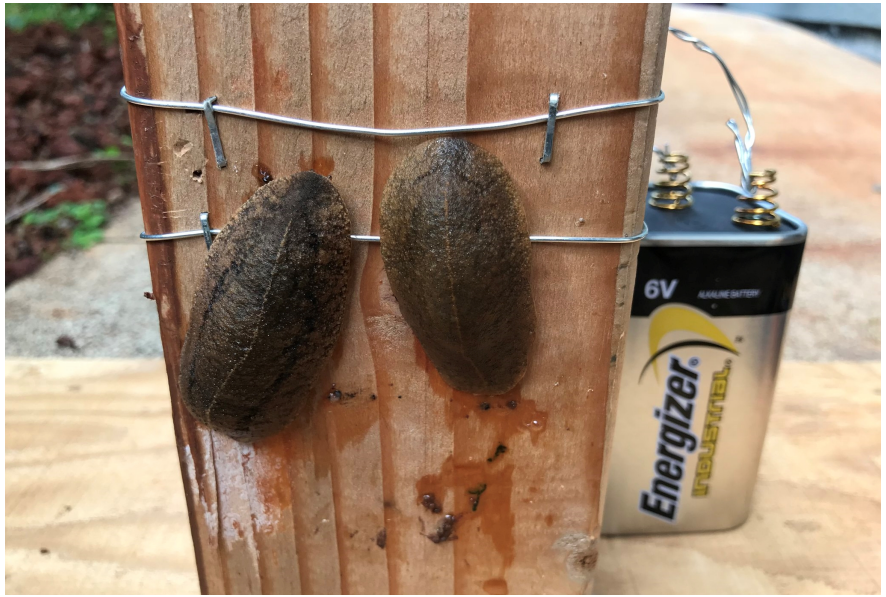
- Uses physical or mechanical methods and/or devices to directly remove, kill, or prevent pests
- Methods that modifying the environment unsuitable for pests
- Considerations
  - Time consuming
  - Consider expenses (deterrents, row covers, hoop houses)
  - Labor (ex. Hand removal) and maintenance



Barriers

- Physically exclude larger pests using fencing

Photo: J. Sugano



Photos: J. Sugano

Barriers for slugs and snails

- Copper tape
- Electric barrier/”fence”

Photo: J. Sugano

Barriers

Netting can be used to keep birds away from seedlings and crops in field

Barriers

- Screens can be used to exclude insect pests

Hoop house

Photo: J. Sugano

Bagging fruit

Photo: A. Kawabata

Barriers- Mulch

- Suppress weed pests
- Plastic mulch, paper, wood chips, etc.
- Reflective mulches and barriers used to repel insect pests (often disease vectors)
  - Ex. Aphids, thrips

Photo: J. Sugano

Traps

Assist with monitoring and reducing populations

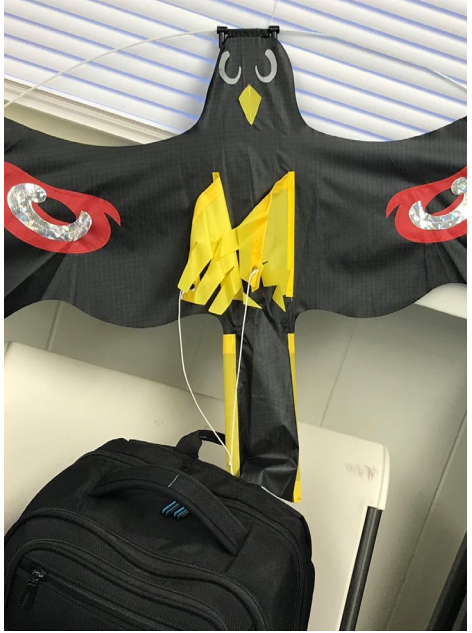
- Ex. sticky traps, pheromone traps, lure/bait traps, light traps

Photo: University of California Statewide IPM

Photo: R. Shimabuku

Traps

- Trap and relocate feral animals

Deterrents

- Visual
- Noise
- Tactile

Water/Irrigation

- Can be used to deter birds
- Can be used to deter and disrupt insect pest cycles

Heat Treatment

- Torching
- Flame Weeders
- Solarization

Mowing

Handpicking

- Physically remove insects and other pests by hand
- May be inefficient for commercial farms especially when populations are established and high
- Can be incorporated into field scouting and monitoring
- Handpicking/hand removal can be done with insects and diseased plants

Biological Control

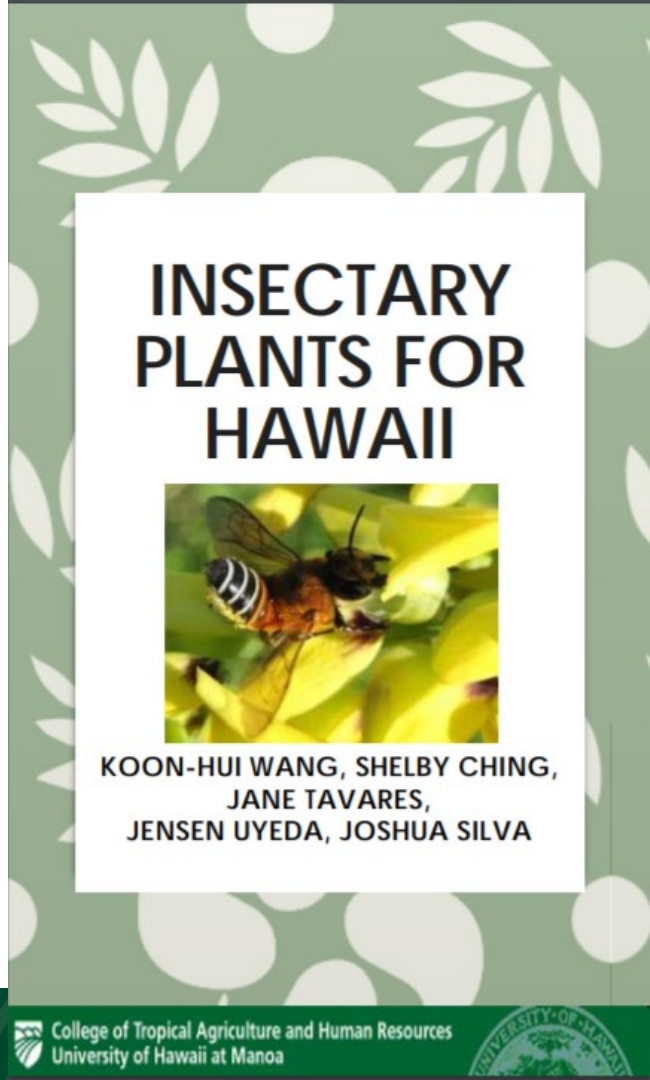
Kylie Tavares

Biological Control

- Is the use of natural enemies to reduce a pest population by using predators, parasites that ordinarily occur in nature
  - Ex: ladybugs, hoverflies, spiders, etc.
- Encourages “good bugs”

Biological Control

- Insectary Plants: those grown to attract, feed and shelter insect parasites and predators to enhance biological pest control
- Insectary plants help increase populations of these beneficial insects



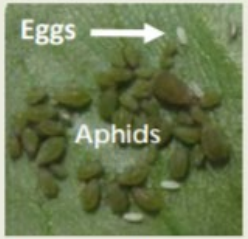
Biological Control

Insectary Plant Considerations

- Know your pest
- Know your beneficial insect and select appropriate plants
- Planting pattern/style
  - Borders, hedgerows, clumps, rows, interplanted
  - Depends on land use and availability, site conditions
- Make sure all other pest management efforts do not kill beneficial insects or interfere with their activities
- Insectary plants may require maintenance and resources

Syrphid / Hover flies (Syrphidae)

While the adults of syrphid flies feed mainly on nectar, pollen, or honeydew produced by aphids, over one third of species of hoverflies have larvae that eat aphids, thrips or other soft body sucking insects. Thus, hover flies eggs are often laid in a cluster of aphids. As the larvae emerged, they feed on the aphids.



Insectary plants attractive to hover flies: Fennel, angelica, coriander, dill, and wild carrot, partly because they are also good hosts of aphids.

Seven-spotted Lady Beetles (*Coccinella septempunctata*)

Seven-spotted lady beetles consume 1,000 to 5,000 aphids in its lifetime. A female can lay over 1,000 eggs at one time. After 2-4 weeks of larva stage, they pupate. The adult last for 3-9 months.

Pupa on carrot flowers

Food Source: Aphids, thrips, whitefly, psyllids, leafhoppers, moths and beetles.

Insectary plants: Cilantro, fennel, dill, and many other flowering plants.

Larva stage

Chemical Control

Chemical Control

- Use of a chemical to prevent, destroy, or repel pests.
- Use as a last method if others don’t work.
- Low toxicity chemicals are considered first.
- If available, use selective vs. broad spectrum chemicals.
- Chemicals should always be rotated with other chemicals to minimize resistance issues.
- Application and timing intervals are important (preharvest intervals).

Pesticide Safety Usage

- Read and follow the label
- Calculate the treatment area
- Calibrate your equipment
- Do not apply more than the maximum allowable limit

https://www.domyown.com/safety-equipment-c-29_395

https://ensia.com/features/developing-world-pesticides

https://americanbeejournal.com/protect-bees-pesticides/

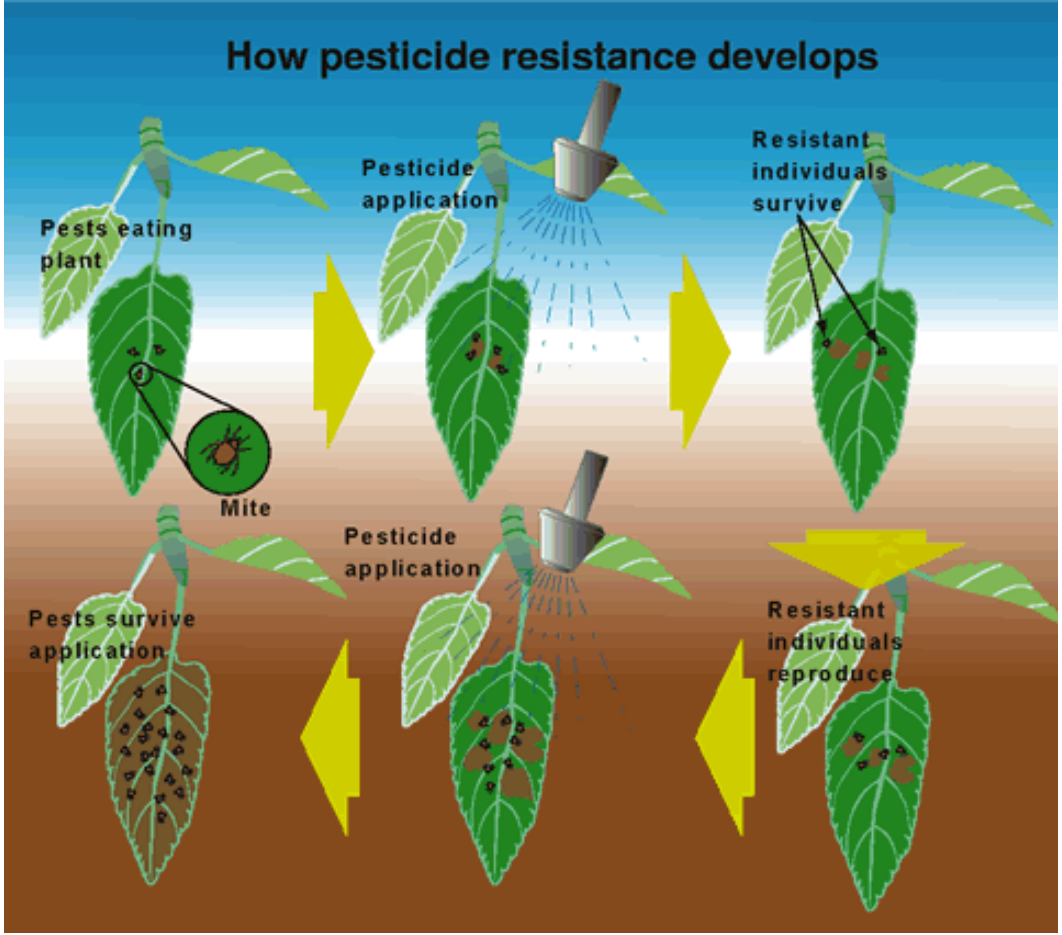
https://www.mysecuritysign.com/fos/caution-pesticide-application-keep-off-lawnboss-sign/sku-k2-1607

Factors Contributing to Pest Resistance

- Rapid reproduction rate of pests (i.e., insects that have many generations per year)
- Repeated applications of the same or similar pesticides
- Use of "broad-spectrum" pesticides (i.e., insecticides that kill all insects, including beneficial insects)
- Pesticides used as the sole means of pest control

Jim Baker

https://slideplayer.com/slide/7773503/#:~:text=Factors%20Contributing%20to%20Pest%20Resistance%20Rapid%20reproduction%20rate%20of%20pests



https://www.canr.msu.edu/grapes/integrated_pest_management/how-pesticide-resistance-develops

- "Ideal Pesticides"
  - **Narrow-Spectrum** = kill only target organism.
  - Breaks down easily into safe materials
  - Does not move around in the environment.

- "Non-Ideal Pesticides"
  - **Broad-Spectrum** = kill more than just the target.
  - Persistent or Can degrade into other cmpds that can be more dangerous
  - Move around in the environment.

https://slideplayer.com/slide/14347131/#:~:text=around%20in%20the%20environment.%20%E2%80%9CNon-Ideal%20Pesticides%E2%80%9D%20Broad-Spectrum%20=%20kill%20more

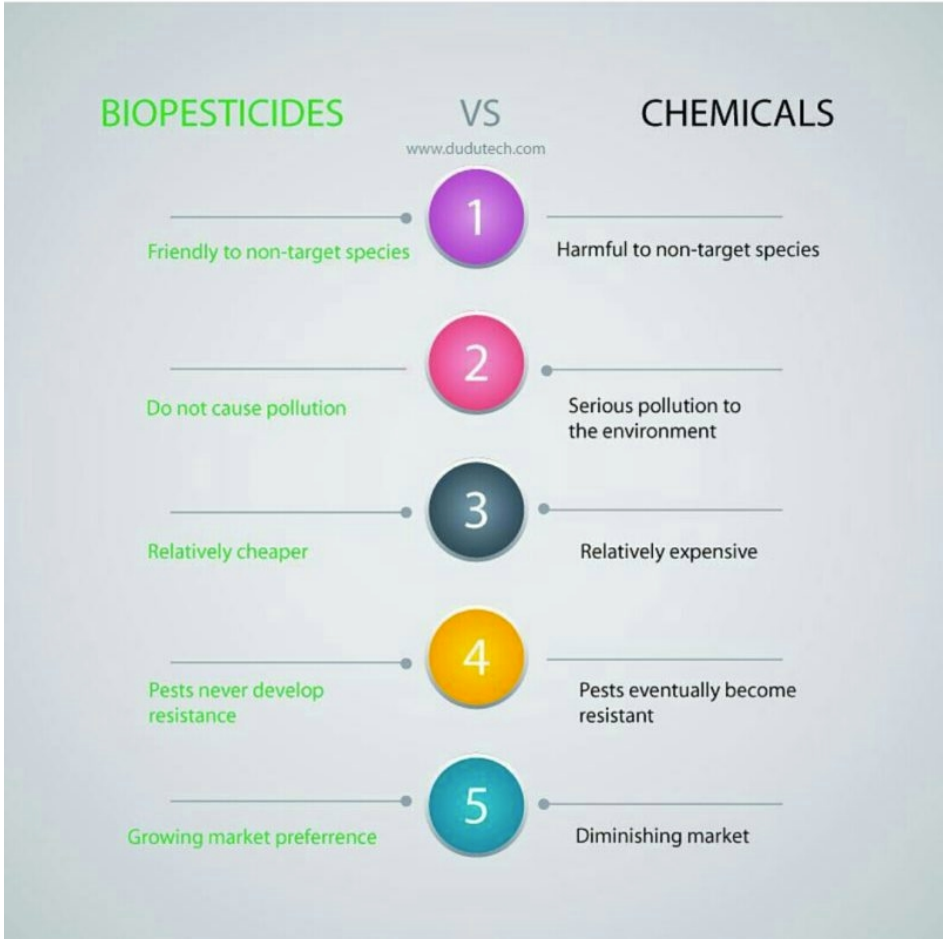
Good Coverage is Important

https://www.youtube.com/watch?v=TenRNA_usxA#:~:text=Pesticidewise:%20spraying%20pesticides%20downwards%20using%20a%20knapsack%20sprayer

BIO PESTICIDES

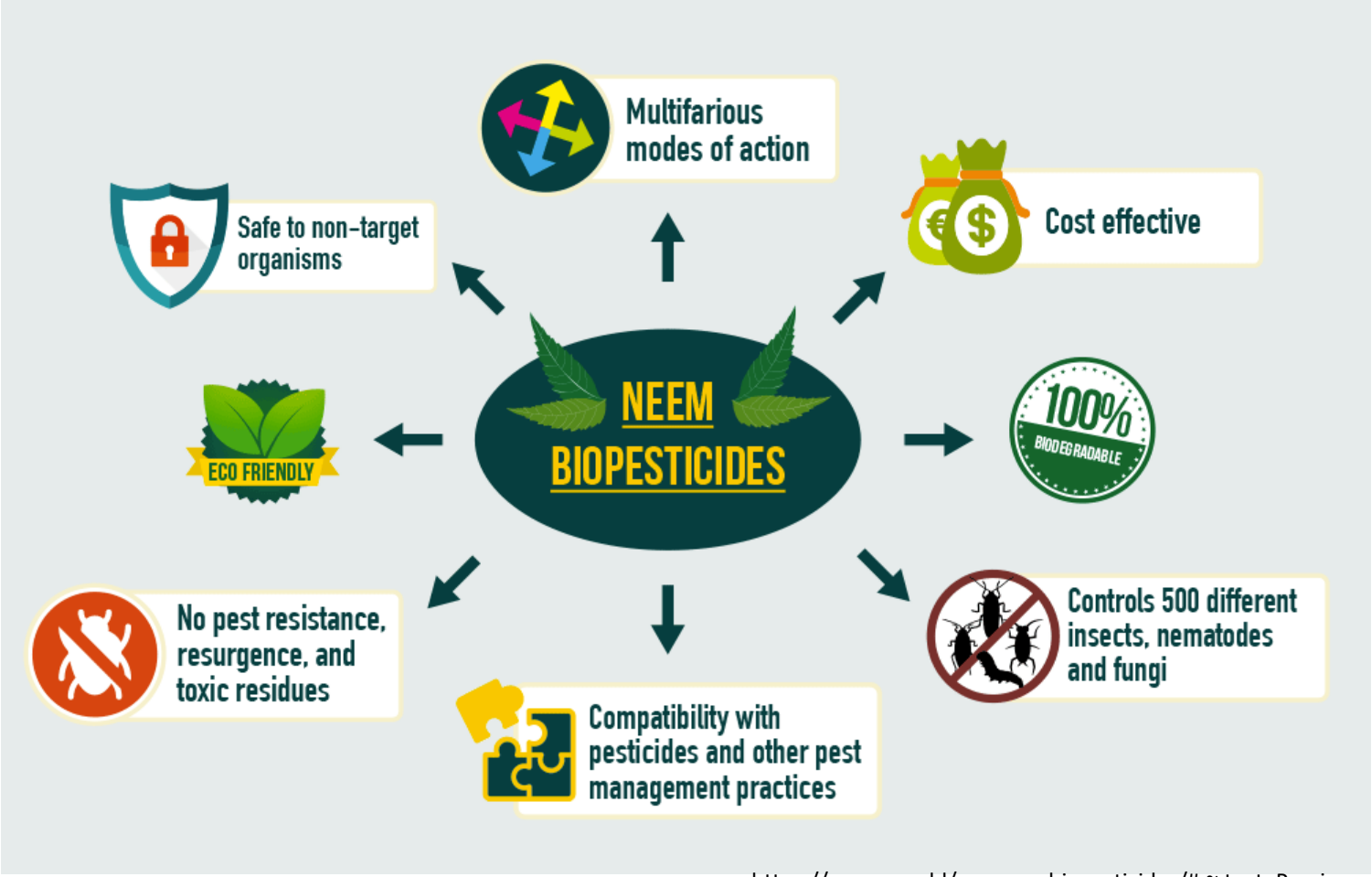
- What are bio pesticides?

- All the living organisms, which are cultivated in the laboratory on large scale and are used and exploited experimentally for the control of harmful organisms are, called biopesticides.
- The examples include insects, virus bacteria, fungi, protozoan and nematodes.



https://www.dudutech.com/advantages-using-biopesticides-compared-chemical-pesticides

Example

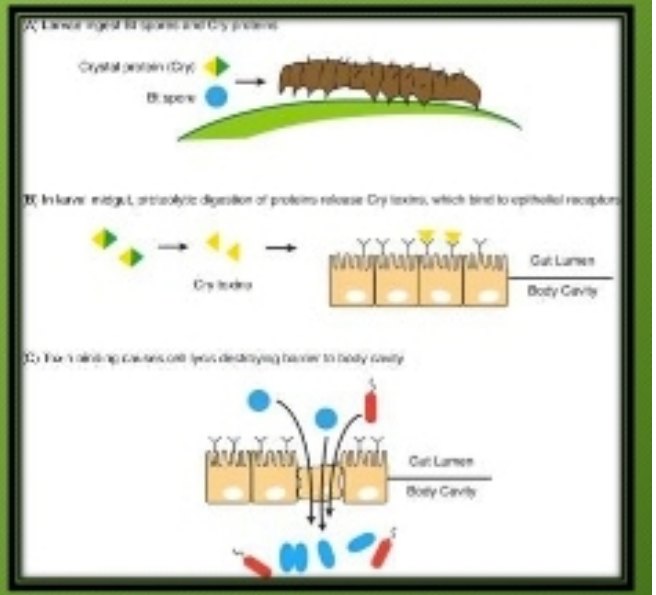


https://neem.world/neem-as-biopesticides/#:~:text=Previous

Example: soil-dwelling bacterium

Bacillus thuringiensis (Bt)

- *Bacillus thuringiensis is the most commonly used* biopesticide globally.
- It is primarily a pathogen of lepidopterous pests like American bollworm in cotton and stem borers in rice.
- When ingested by pest larvae, Bt releases toxins which damage the mid gut of the pest, eventually killing it.
- Main sources for the production of BT preparations are the strains of the subspecies *kurstaki, galeriae and dendrolimus*



https://www.slideshare.net/ruchirani022/biopesticide-61776159#:~:text=Baculoviruses%20%E2%80%A2%20These%20are%20target%20specific%20viruses%20which%20can%20infect

Example

- ***Beauveria bassiana*** is an entomopathogenic fungi that causes white muscadine disease in a range of insect including whiteflies, aphids, thrips, grasshoppers and certain types of beetles.
- It does not need to be ingested by the host; ***B. bassiana*** spores simply need to come in contact with a host.

https://biologicwine.co.za/2018/05/29/beauveria-bassiana-broadspectrum-used-focus-control

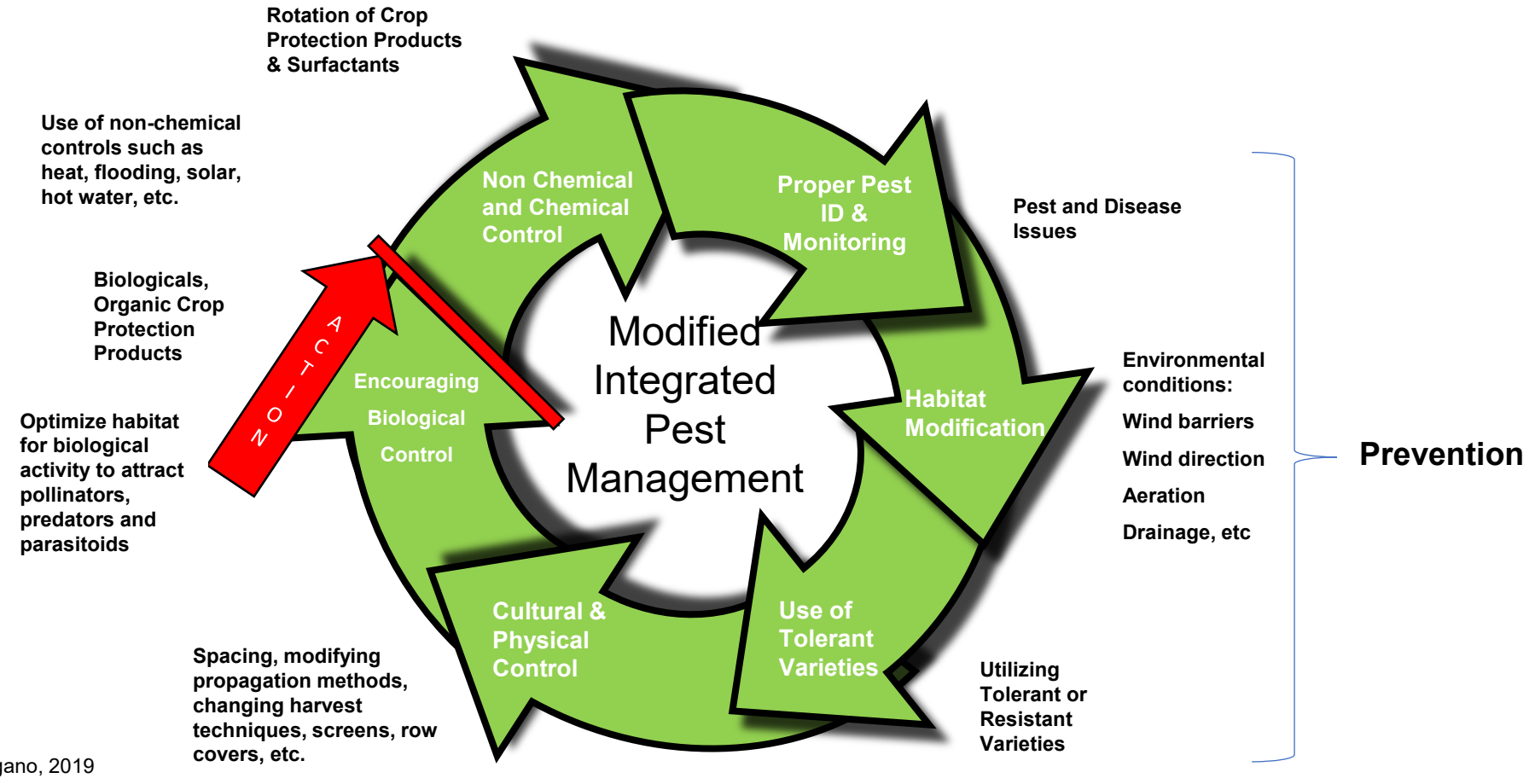
https://www.sciencedirect.com/science/article/pii/S0022201118301204

https://agfuse.com/article/insecticide-beauveria-bassiana-bed-bug-treatment

IPM Summary

Pest Management Key Points

- IPM is an ecosystem-based strategy that focuses on **long-term** prevention of pests or their damage through a combination of techniques
- Each farm and location will be different
- Become familiar with the pests of your crop(s)
- Year-round farming increases complexity of IPM in Hawai‘i
  - Winter? What’s that?
- Incorporate preventative strategies and practices
- Follow crop protection labels to protect yourself, neighbors, and the environment


Rotation of Crop Protection Products & Surfactants
Use of non-chemical controls such as heat, flooding, solar, hot water, etc.
Biologicals, Organic Crop Protection Products
Optimize habitat for biological activity to attract pollinators, predators and parasitoids
Spacing, modifying propagation methods, changing harvest techniques, screens, row covers, etc.
Utilizing Tolerant or Resistant Varieties
Pest and Disease Issues
Environmental conditions:
Wind barriers
Wind direction
Aeration
Drainage, etc
Prevention
Modified Integrated Pest Management
Non Chemical and Chemical Control
Proper Pest ID & Monitoring
Habitat Modification
Use of Tolerant Varieties
Cultural & Physical Control
Encouraging Biological Control
ACTION

Sugano, 2019

Mahalo!

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