Integrated Pest Management

for the Aquaponic Greenhous

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THE AQUAPONICS ASSOCIATION

What is IPM?

Integrated Pest Management is a science-based approach that combines a variety of techniques. By studying their life cycles and how pests interact with the environment, IPM professionals can manage pests with the most current methods to improve management, lower costs, and reduce risks to people and the environment.

IPM tools include:

- Alter surroundings
- Add beneficial insects/ organisms
- Grow plants that resist pests
- Disrupt development of pest
- Prevention of pest problem developing
- Disrupt insect behaviors
- Use pesticides

1 IDENTIFY/ MONITOR

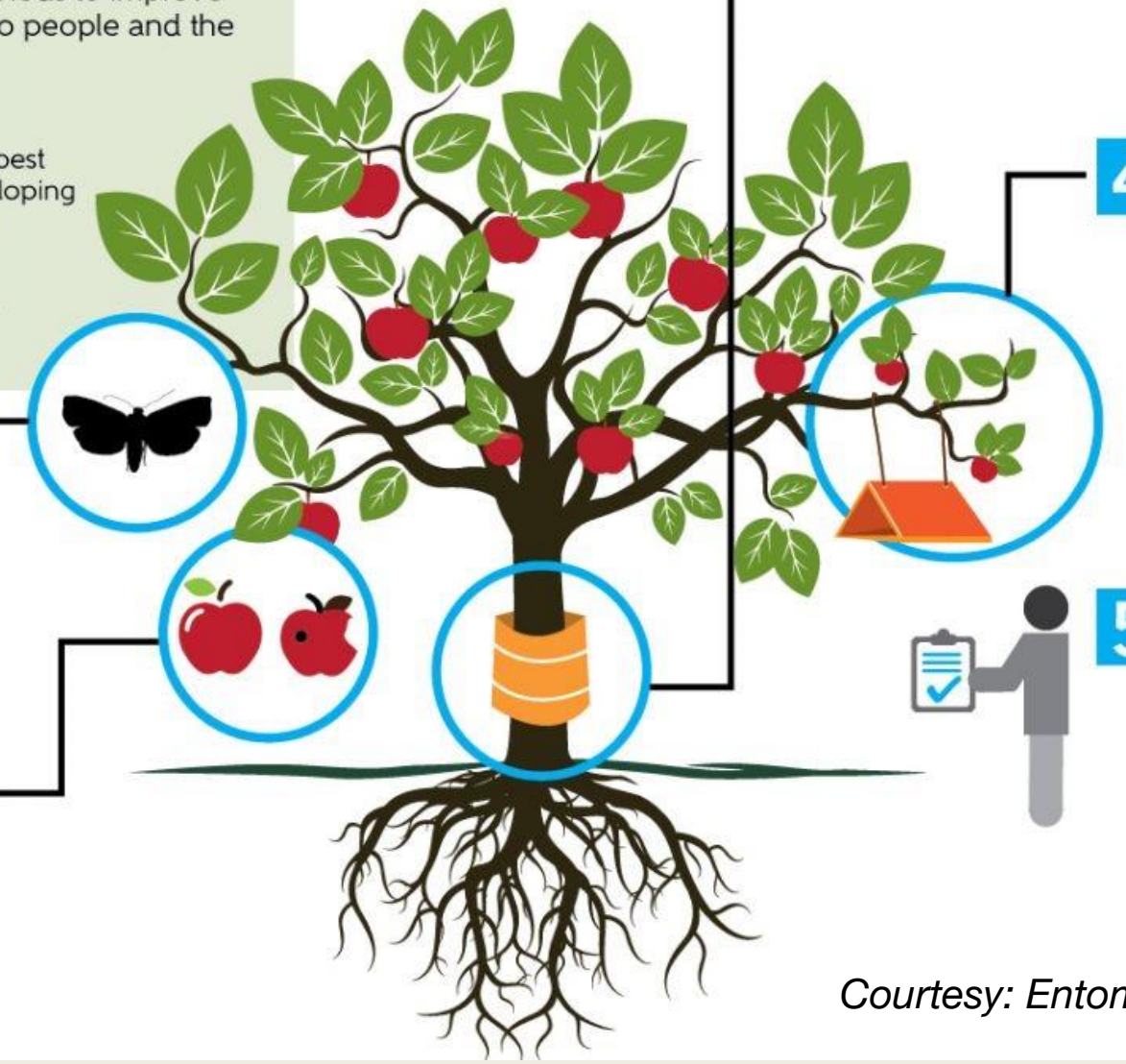
Determine the causal agent and its abundance (contact your local extension agent for help).

2 EVALUATE

The results from monitoring will help to answer the questions: Is the pest causing damage? Do we need to act? As pest numbers increase toward the economic threshold further treatments may be necessary.

3 PREVENT

Some pest problems can be prevented by using resistant plants, planting early, rotating crops, using barriers against climbing pests, sanitation, and sealing cracks in buildings.



4 ACTION

IPM uses multiple tools to reduce pests below an economically damaging level. A careful selection of preventive and curative treatments will reduce reliance on any one tactic and increase likelihood of success.

5 MONITOR

Continue to monitor the pest population. If it remains low or decreases, further treatments may not be necessary, but if it increases and exceeds the action threshold, another IPM tool should be used.

Courtesy: Entomological Society of America

What do you plan for?

Environment

- Temperature
- Humidity
- Lighting
- Ventilation
- Greenhouse
- Material flow

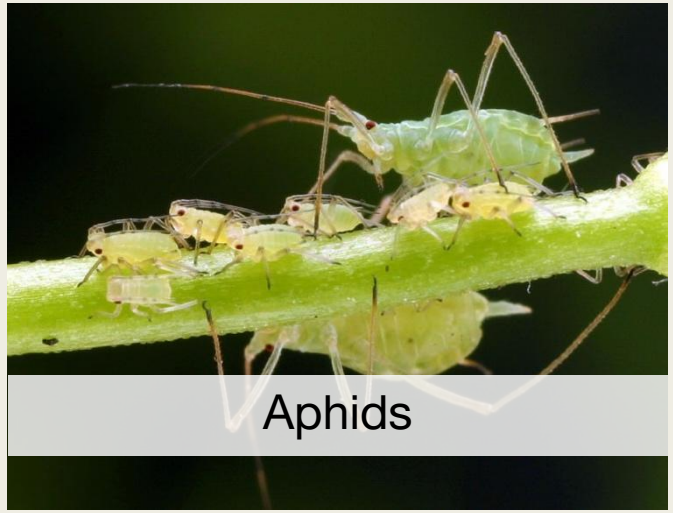
Crops

- Cultivar type
- Seed Source
- Pest record
- Growing stages
- Elicitors
- Planting media

Control Agents

- Mechanical traps
- Botanical sprays
- Bio-control
- Sanitation
- Synthetics

Meet the pests



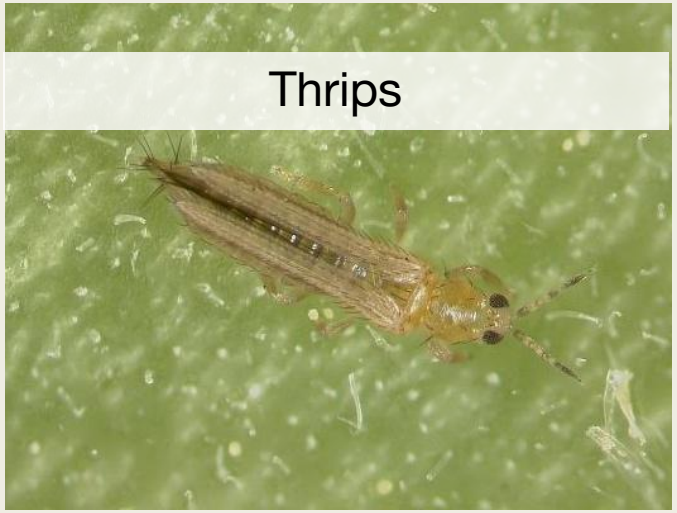
Aphids

Mealy bugs

Spider Mites

Spodoptera

Thrips



Whitefly

WATERFARMERS AQUAPONICS

PREVENTION

Sanitation, Workflow, Seed reliability, Employee awareness, Facility design

AVOIDANCE

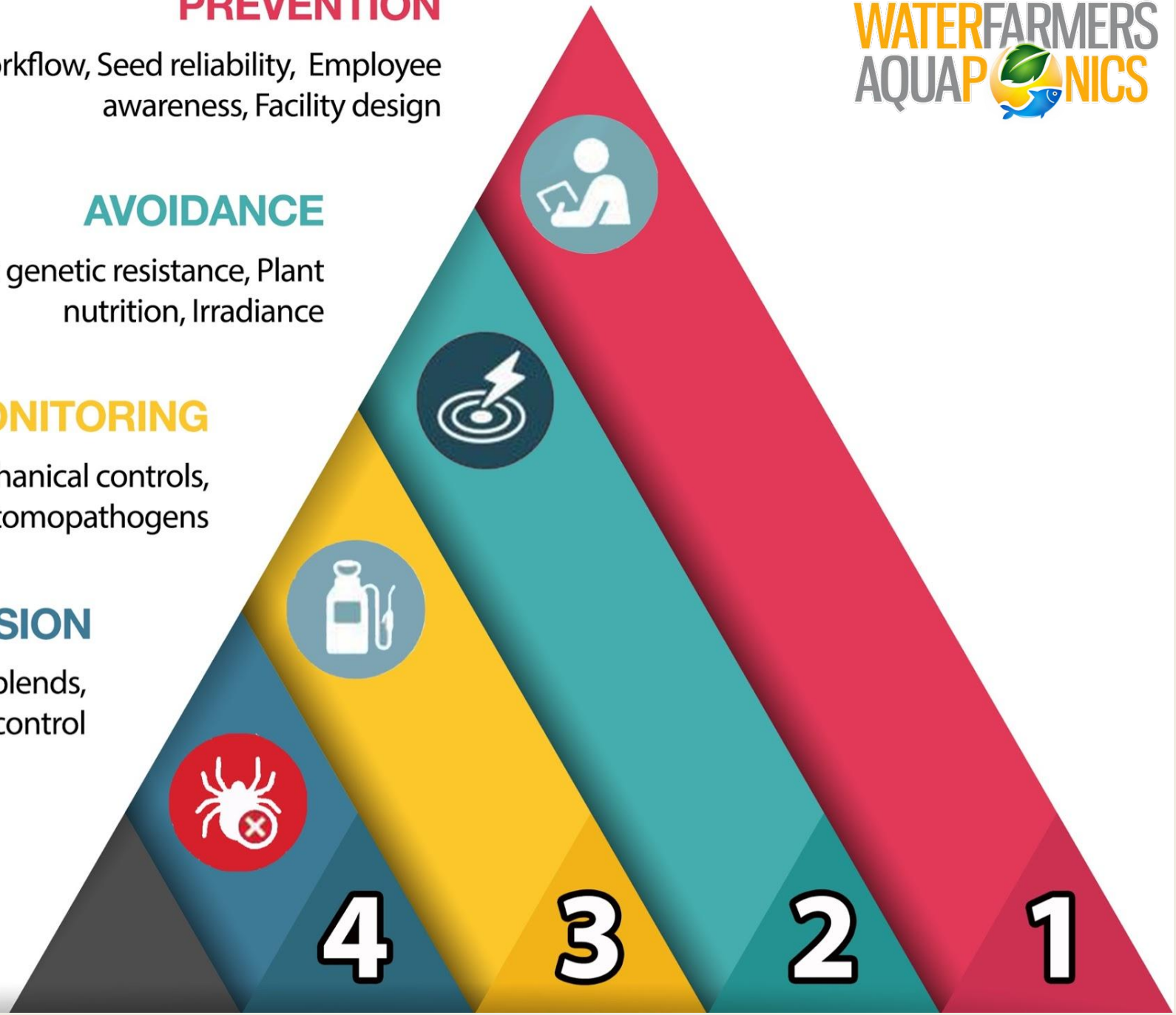
Resistance elicitors, Host genetic resistance, Plant nutrition, Irradiance

MONITORING

Pheromone traps, mechanical controls, Parasitoids, Predators, Entomopathogens

SUPPRESSION

Botanical pesticides, Essential oil blends, Synthetic control



THE IPM PATHWAY

Food safety and IPM

- NESTED SANITATION PROTOCOLS
  - *GAP and HACCP require, nested sanitation levels while addressing human interaction with the greenhouse and its produce.*

- SEGRATED WORK FLOW
  - *Separate in and out paths for worker traffic into the greenhouse*
  - *Change of attire and protective wear at different sanitation check points*
  - *Minimum handling of produce post harvest*

- PRETREATMENT OF SECONDARY PLANT MATTER
  - *HACCP mandates that all plant matter for whatever purpose must enter the growing process only post disinfection and sanitation*
  - *All secondary plant residue is subject to a sanitation protocol to avoid transfer of pests from unknown locations to the greenhouse*

Greenhouse Design

- GLAZING
  - *Anti condensation material or treatment is mandatory*
  - *Choose the right fabric for balanced light diffusion and heat retention*

- AIR LOCK ENTRANCE
  - *All entrances to greenhouse must be an external double door air lock chamber, for effective environmental control and pest management*

- POSITIVE AIR PRESSURE
  - *Winged insect pests can be prevented from entering a greenhouse from the outside if they are met with resistance in the form of air pressure as they try to enter through the vents and doors.*

- QUARANTINE
  - *Checking and quarantining plants brought into the greenhouse for pest infestations is important to ensure that no infested plants are introduced into the greenhouse.*

Greenhouse Ventilation

- A major concern of growers considering screening is the reduction in air flow. Airflow resistance, primarily a function of hole or mesh size, varies widely among screen products.
- Reduced air flow can lead to overheating of the greenhouse, and stress on the fans (in the case of fan-ventilated greenhouses) that have to work harder to pull the same amount of air through the partially-blocked vent.
- To provide adequate air flow for ventilation, the area of the screen that covers the vent/shutter opening has to be increased. This is usually done by providing a frame or structure over the intake that will support additional material.

Sanitation Technologies

- SOLARIZATION
  - *Easiest and simplest option*
  - *Exposure to sun is a simple yet effective sanitation tool*

- UV LAMPS
  - *Nursery seeding mix pre-treatment*
  - *Tools and implements*
  - *Growing media & Net pots*

- STEAMING
  - *Tools and implements*
  - *Netpots, DWC boards*

- OZONE GENERATORS
  - *HVAC outflows*
  - *Packing lines*
  - *Stores and Inventory facilities*

- SYNTHETIC TREATMENT
  - *Cleaning of tools*
  - *Sanitation of work space*
  - *Sanitation of growing media*
  - *Treatment of disease and pest*

Phyto-sanitation

- Double access doors (with interlocking)
- Foot baths with disinfectants
- Washing stations for humans and tools
- Removal of weeds from greenhouse surrounding
- Avoid water splashing or condensation on plant surface
- Ensure no weeds grow inside the greenhouse
- Have a proper removal and disposal plan for plant matter in the greenhouse

Start from the beginning

- Seed storage
  - *Pelletize seeds (Trichoderma, EM, Kaolin clay, Tapioca starch)*
  - *Store in temperature controlled sealed cabinets*

- Sanitation of seeding mix
  - *Avoid store or farm bought compost*
  - *Avoid all land animal based manure*
  - *Sanitation through UV or Steaming is mandatory*

- Automated seeding machines
  - *Minimize handling of seeds and seeding mix*
  - *Precision based seeding*

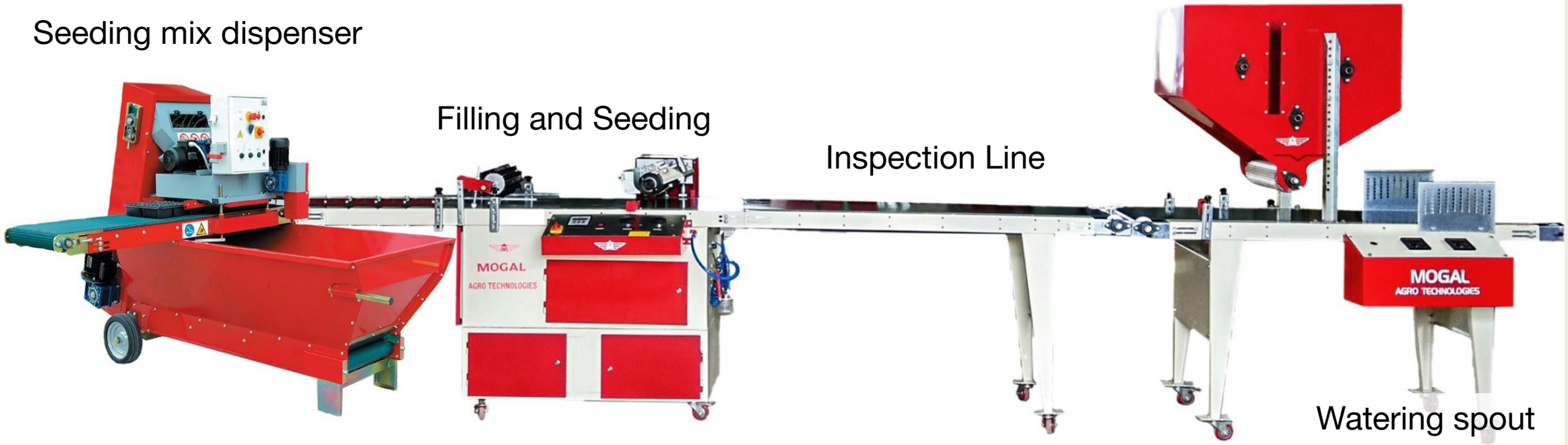
Seeding Machine

Seeding mix topper

Seeding mix dispenser

Filling and Seeding

Inspection Line



Watering spout

Pest Detection and Monitoring

- Adhesive color sheet traps
- Pheromone traps
- Potato discs
- Liquid pheromone baths
- Bug zappers

Pest Detection and Monitoring

- Adhesive color sheet traps
  - *Monitors flying pests such as whiteflies, thrips, fungus gnats, shore flies, leaf miners, psyllids, winged aphids, and leafhoppers.*
  - *Blue color: Thrips*
  - *Yellow color: Flying aphids, fungus gnats, whitefly and leafminers*

Pest Detection and Monitoring

- Pheromone traps
  - *Synthetically produced pheromones mimic the chemicals produced by insects and are used to lure specific insect species to specially-designed traps, (example: Methyl Eugenol)*
  - *Pheromone traps can be used to: (1) detect early pest infestations, such as the first occurrence of migratory pests, (2) define areas of pest infestations, (3) track the buildup of a pest population, and (4) help in decision making for insect pest management.*
  - *Relatively easy to use and inexpensive, species specific, and environmentally benign, they make ideal tools for IPM programs.*

Botanical Pesticides

Garlic Spray

Target Insects
Aphids, cabbage loopers, grasshoppers, June bugs, leaf hoppers, mites, squash bugs, slugs, and whiteflies.

Preparation
100ml of minced garlic cloves with 30ml mineral oil. Let soak for at least 24 hours. Strain. Mix 1 teaspoon of fish emulsion with 500ml. water. Add 1 tbsp castile soap. Slowly combine both mixtures together. Should last for several months if sealed in a glass container.

Application
Mix 2 tbsp with 500ml of water and spray.

Botanical Pesticides

Orange Peel Spray

Target Insect
Soft-bodied pests such as aphids, fungus gnats, mealy bugs, and ants.

Preparation
Add 2 cups boiling water over peelings of one orange. Wait 24 hours.
Strain mixture into glass jar, mix in a few drops of castile soap.

Application
Spray on insects or on ants and their nests.

Botanical Pesticides

Horseradish spray

Target Insect
Aphids, blister beetles, caterpillars, Colorado beetles, and soft-bodied insects.

Preparation and Application
Bring 3 cups of water to boil, add 2 cups cayenne peppers and a 1-inch piece of chopped horseradish root.

Let steep for 1 hour, cool, strain, and spray.

Botanical Pesticides

Pepper Spray

Target Insect
All-purpose insect spray.

Preparation
Mix half a cup finely chopped or ground hot peppers with 1 pint of water. (cayenne, chili, dill, paprika, and red and black peppers are recommended) Let it set for 24 hours. Use as is to drench soil, or strain mixture through cheesecloth until you have a clear liquid for a spray.

Application
For foliage, add a few drops of castile soap. Keep away from eyes and skin when using.

Botanical Pesticides (Leaf extracts)

- Neem-Tobacco Extract

  - *Tobacco leaf paste (5kg)*
  - *Neem leaf paste (2kg)*
  - *Garlic paste (1kg)*
  - *Green chilli paste (1kg)*

- *Boil, ferment over 24 hours and foliar spray*

Botanical Pesticides (Leaf extracts)

- 10 leaf extract
  - *Calotropis Procera*
  - *Nerium Indicum*
  - *Lantena Camella*
  - *Carica Papaya*
  - *Vitex Negundo*
  - *Annona Squamosal*
  - *Ticinus Communis*
  - *Aristolochia*
  - *Pongamia Pinnata*
  - *Tinospora Cordifolia*

- *Mix with Neem leaf extract, boil, ferment and foliar spray*

Essential oil blends

Pest	Oil blend
Aphid (Regular)	Thyme, Peppermint, Clove, Rosemary
Aphids (Infestation)	Peppermint, Sandalwood, Idaho Balsam Fir
Fly	Rosemary, Sage, Peppermint, Lavender, Eucalyptus
Fungus Gnat	Patchouli, Spearmint
Moth	Hyssop, Peppermint, Cedarwood, Citronella
Mite	Lemongrass, Sage, Thyme, Lavender
Caterpillar	Peppermint
Thrip	Cedarwood, Citronella, Lemongrass, Lavender

Components of a Bio-Pesticide

WATERFARMERS AQUAPONICS

Bio Toxin

- Pyrethrum
- Rotenone
- Quassia
- Nicotine

0.5 oz
Any one

Carrier Oil

- Neem
- Rapeseed
- Mustard
- Sesame
- Castor

1 oz
Any one

Essential Oil

- Citronella
- Eucalyptus
- Catnip
- Cinnamon
- Thyme

5 drops
each

Fungicide

- Pine oil
- Fennel oil
- Lecithine
- Laminarine
- Actinomycete

0.5 oz
Any one

Bio-control Agents

- Parasitoids
  - *Insects or organisms that use a host organism to hold their larvae which in turn destroy the host*
- Entomopathogens
  - *Naturally occurring bacteria, fungi, nematodes, and viruses infect a variety of arthropod pests and play an important role in their management.*
- Predators
  - *Repeated release of predators are often needed in order to keep pace with the high reproductive rate of pests in the greenhouse. Their effectiveness depends upon their predation rate, ability to locate prey and increase in number.*

Bio-control Agents for Aphids

Agent	Characteristic
Aphelinus abdominalus	Parasitic wasps; females parasitize and feed upon aphids for several weeks
Aphelinus ervi	Same as above
Aphidoletes aphidomyza	Aphid gall midge; resembles fungus gnat. Young feed exclusively on aphids
Ladybird Beetles	Young and adult feed on aphids. Predators.
Crysoperla carnia	Green lacewings; larvae are voracious predators, Dry climates.
Crysoperla rufliabris	Recommended for humid areas
Beavaria bassiana	Pathogenic fungi

Predators

Lady beetle

Skink

Lacewing Larvae

Destroyer

Mantis

Dragonfly

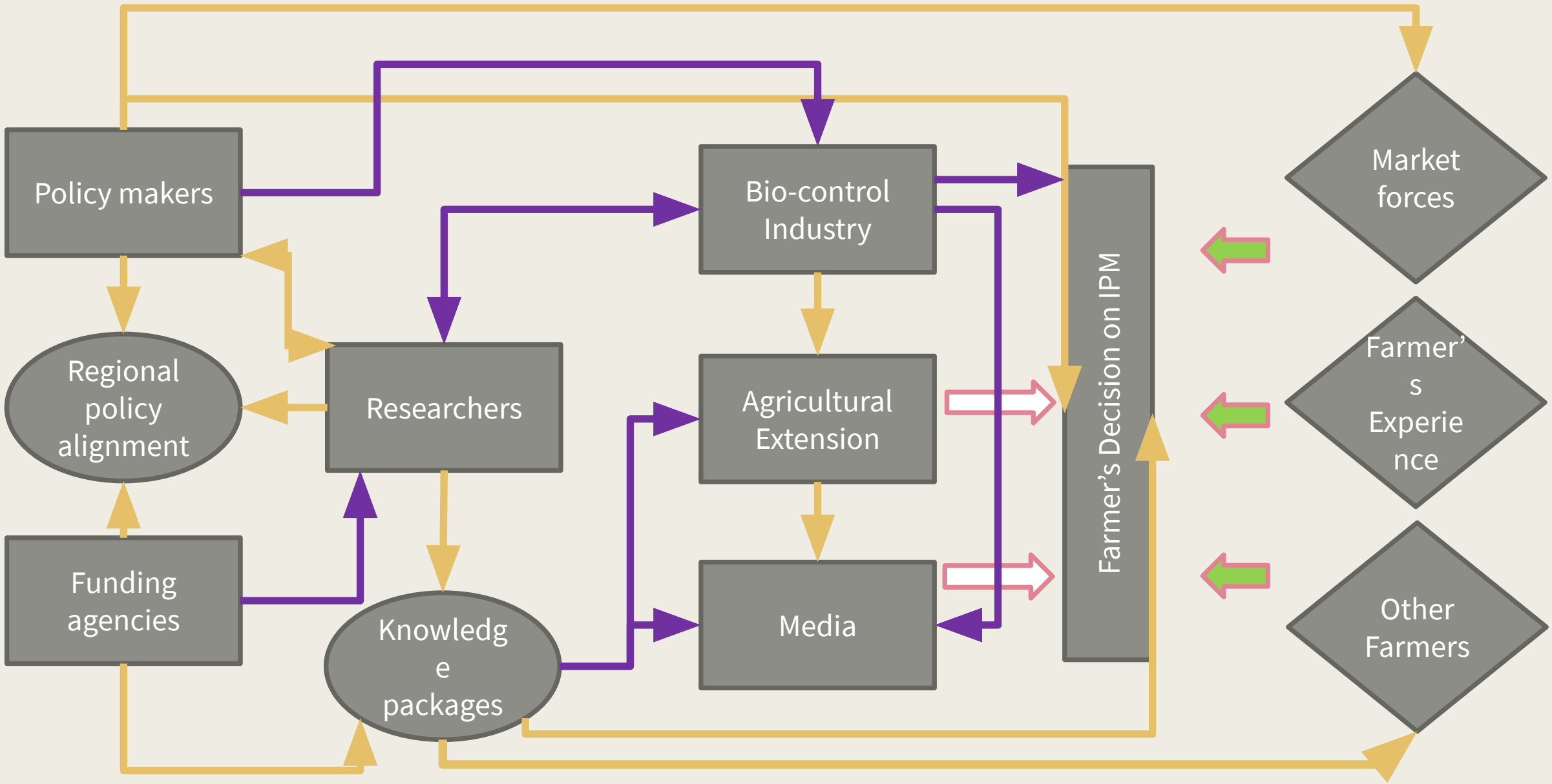
Role of Synthetics

- Hydrogen Dioxide
  - *The only OMRI approved commercial greenhouse disinfectant.*
- Ethyl or Isopropyl Alcohol
  - *Permitted disinfectant*
- Bicarbonates
  - *Potassium bicarbonate is especially effective in controlling mildew and leaf borne diseases.*

Developed

The IPM stakeholder model

Needs attention



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