Introduction to Insect Management
for Permaculture Research Institute Cold Climate
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I. Integrated Pest Management (Part 1)

Peace is easily maintained;
Trouble is easily overcome before it starts.
The brittle is easily shattered;
The small is easily scattered.
Deal with it before it happens.
Set things in order before there is confusion.
- Lao Tzu, from *Tao te Ching*, Chapter 64 (Trans. by English & Feng)

_Brief Description of Integrated Pest Management (IPM)
IPM is a balanced and *pragmatic* approach to managing pests (including plant-feeding insects and disease-causing organisms) that can include (but does not necessarily need to) involves a broad spectrum of pest management tools and techniques into the decision-making process. For urban growers, the most concise (and most useful) description of IPM is that it is a proactive approach to pest management. Growers who apply IPM principles into their growing systems prepare for and expect pests—and do not just react when pests reach outbreak levels. IPM is also an *interdisciplinary practice*. It requires "plant people" to research the insects who are competing for plant material.

_History of IPM
Many critics questioned the pesticide-only approach to crop production that grew out of the 1950s. Alternative approaches were developed, such as crop rotation, changing planting dates, and conserving natural enemies. Because of the ongoing tensions between pocketbook economics and environmental stewardship, ideas related to IPM were slow to take hold, but gradually more full-time growers saw sense in reducing both the amount and cost of frequent pesticide applications. Interest in "green" products and organic food spiked in the 1990s and in 2012 even big box stores carry the kinds of pest control products that in 2000 were mostly available only by mail order from small independent companies.

_IPM "Continuum"
The "IPM Continuum" is a way of describing how IPM tools are incorporated into the growing system (Jacobsen, 1997, p.386.)

NO IPM: No scouting. Pesticide application without thresholds.
LOW IPM: Scouting plus threshold-based pesticide application.
MODERATE IPM: Scouting plus threshold-based pesticide application plus 1-2 IPM elements.
HIGH or BIOINTENSIVE IPM: Scouting plus threshold-based pesticide application plus 3-4 IPM elements.

_FOUR "Ts"Approach to IPM
IPM is a decision-making process, and there are many factors to consider when deciding the appropriate action to take. The Four T's (4T) approach is a way to break down this process into smaller, more manageable bits. The four Ts are the following:

- **Target** (Pest and life cycle stage)
- **Timing** (When to act appropriately for the certain life cycle stage)
- **Tool** (Which product or tool to kill or thwart the bugs), and
- **Technique** (How specifically you might use your product or tool to enhance its efficacy against your bugs).

II. IPM Tools (Part 1)

_Cultural Tools

- Key ideas: Using plants or growing practices to enhance pest management efficacy.

a. Plant care (e.g., fertilizer, mulching, watering regimes)
b. Global plant location (e.g., soil quality, shade/light, matching location to plant preferences)
c. Local plant location (e.g., spacing of plants, plant guilds, planting with trap plants*,)
c. Plant selection (e.g., host or disease resistant varieties, zone appropriate, heat/drought tolerant)
d. In-season time-based planting techniques (e.g., late season planting)
e. Between season time-based planting techniques (e.g., crop rotation)
e. Pest habitat reduction (e.g., weeding, removing alternative crops or secondary hosts from the area)
f. Sanitation (e.g., washing tools, protective clothing, greenhouse protocol, solar soil sterilization)
g. Soil care (e.g., fertilizers, soil amendments, mulching, tilling)

*Also included in Monitoring and Trapping.

_Mechanical and Material Tools

- Key Idea: Using mechanical tools or materials to alter the conditions of the growing area.

a. Temperature control
b. Row covers/sleeves/bagging
c. Airflow
d. Irrigation
e. Land preparation
f. Mowing
g. Flaming
h. Soil solarization
i. Insect vacuums

_Biological Tools

- Key idea: Using living organisms (i.e., natural enemies) to reduce or interfere with pest populations.

a) Types of biocontrol approaches
    Conservation biocontrol
    Augmentation biocontrol
    Classical biocontrol

b) Types of bio-agents
    Predators
    Parasitoids
    Plant-feeders
    Pathogens

c) Insect shipments and release techniques
    1. Finding a reputable biological control supplier.
    2. Evaluating the cost of biological control (shipping).
    3. Checking the quality of your shipment.
    4. Ideal release times during the day/evening.
    5. Refrigeration of living organisms to delay emergence or prolong life.
    6. Multi-species releases.
    7. Association of Natural Biological Control Producers (ANBP).

_Monitoring and Trapping Tools

- Key idea: Using traps and indentification tools to identify where pests are and measure their presence.

a. Sticky traps
b. Sticky traps with pheromone attractants
c. Sticky traps with mating disruption
d. Collecting data
e. Trap plants*

*Also listed as a Cultural Control.

_Chemical Tools

- Key idea: A pesticide is any A pesticide is any substance or mixture of substances intended for: preventing, destroying, repelling, or mitigating any pest.[6]

Note: The EPA definition of pesticide is—excuse the pun—broad spectrum. There is a reason for this. Any chemical formulation that kills insects can be placed under the EPA's definition, including fairly benign products such as kaolin clay and diatomaceous earth. The definition, I believe, is acceptable because it simplifies the total organization while allowing the different categories of pesticides. Note: The EPA definition of pesticides includes herbicides, miticides, and fungicides.

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Conventional Pesticides (synthetic, poisons)

Organophosphates and Carbamates -

MOA: Synaptic poisons. Prevents nerve impulse transmissions. Insects "think" themselves to death.
Ex. organophosphate pesticide common names: chlorpyrifos, diazinon
Ex. organophosphate pesticide brand names: DuraGuard, Knox Out GH
Ex. carbamate pesticide common names: bendiocarb
Ex. carbamate pesticide brand names: Turca

B. Chloronicotinyls (aka, Neonicitinoids) – "Imidacloprid", "Merit", "Marathon", "Imicid"

MOA: Acetylcholine agonist (mimic). Inhibits nerve impulse reception, prevents normal behavior when messages cannot be "received"

C. Insect Growth Regulators (IGR) – diflubenzuron, fenoxycarb, pyriproxifen

MOA: Chitin synthesis inhibitors or juvenile hormone mimics.
Example pesticide brand names: Adept, Precision, Enstar II, Distance

D. Pyrethroids

Mode of action: Affects the nervous system. Axonic toxins.
Example pesticide common names: Pyrethrin
Example pesticide brand names: 1100 Pyrethrum TR, EXclud

Biorational Pesticides, including Botanicals*

E. Insecticidal oils and soaps

MOA: Suffocants, dessicants

Insecticidalsoap – Safer Soap, Des X Insecticidal Soap Concentrate

MOA: Dessicant, irritant, immobilizes pests

Horticultural oil – Sesame oil, Suffix Oil-X

MOA: Suffocant, Immobilizes pests

Hot pepper oil, garlic, or other herbal sprays

MOA: Irritant, repellant, suffocant, or dessicant, or a combination of these.

F. Microbials (Pathogens)[5]

Bacillus thuringiensis (Bt) – Dipel, Xentari

MOA: *Bt* enzyme degrades the stomach in the host, causing inability to feed and infection.

Beauvaria bassiana – "Mycotrol"

MOA: *When Beauveria bassiana spores come into contact with vulnerable insects, they germinate. When they germinate, the hyphae grow and dissolve the cuticle of the insect, and eventually grow inside the insect; once inside the insect, the fungal hyphae secrete a toxin that suppresses the immune system. When the insect is dead, B. bassiana continues to grow and outcompete intestinal bacteria.*

Streptomyces fungus – Mycostop, Actinovate AG

MOA: *See explanation of MycoStop in IPM folder*

Trichoderma – RootShield

MOA: 1) Competitive exclusion and 2) Mycoparasitism

Saccharopolysora spinosa – Spinosad, Conserve, Entrust, Tracer, Success, etc

G. Minerals (Repellents or Dessicants)

Kaolin clay – "Surround"

MOA: When kaolin clay dries, it leaves a mineral layer that pests do not like.

Diatomaceous earth

MOA: When certain insects or slugs come into contact with diatomaceous earth, it cuts their cuticle and causes infection or they die from dessication (aka., "water balance disruptor).

H. Botanicals* (Stomach poisons, Suffocators, Repellants, or Nervous system poisons)

Rotenone

MOA: Contact and stomach poison found in several subtropical leguminousshrubs – derris, cube, timbo

Pyrethrum/Pyrethrins – Pyganic, Safer Insect Killer with soap (III)

MOA: Nervous system stimulant. Affects the sodium channels in the nervous systems of insects.

Neem – Agroneem, AZA-Direct, Azatrol, Ecosense, Ecoside, Neemix, Ozoneem, NeemAzad 1%

MOA: Growth inhibitor, feeding deterrent, mating disruptor.

Sabadilla – Applied as a dust with sulfur or lime. Also toxic to bees.

MOA: Contact and stomach poison made from seeds of a Lily family plant.

Ryiana – Longer residual activity. Toxic to mammals.

MOA: Stomach poison made from stems and roots of a South American shrub, *Ryania speciosa*.

Other – Hot pepper, herb, seed, or garlic sprays.

MOA: Irritant, surfactant, and can be used as repellant sprays.)

III. Insect Classification, Identification, Biology, and Function (Part 1)

A. Insects and Mites

Examples: Multicolored Asian ladybeetles, cabbage butterfly, leafcutter bees, parasitic wasps

B. Insect life Cycles (4)[1]

1. Complete Metamorphosis aka *Holometabolous* (e.g., butterflies, moths, beetles, flies, etc.)
2. Incomplete metamorphosis aka *Hemimetabolous* (e.g., dragonflies, damselflies, mayflies)
3. Gradual metamorphosis aka *Paurometabolous* (e.g., grasshoppers, true bugs)
4. No metamorphosis aka *Ametabolous* (e.g., silverfish, firebrats)

C. Insect and mite mouthparts (5)[2]

1. Chewing 2. Piercing-sucking 3. Rasping-sucking 4. Sponging 5. Cutting-Sponging

D. Insect and mite functions (7)[3]

1. Predator 2. Plant feeder 3. Parasitoid 4. Decomposer/Scavenger
5. Pollinator 6. Pathogen (vector) 7. Food

E. Insect Orders[4]

- 21 Major Orders[4]
- Insect orders poster (on the Green Noise website)

F. Insect Degree Days (a more accurate way to predict insect emergence)

Add the maximum temperature and the minimum temperature for a day, divide by 2, and then subtract the base temperature (BT) for the insect (BT usually 50).

Example: 80 (max) + 50 (min) = 130
130/2 = 65
65 – 50 = 15 Degree Days

Degree Day Resources
Minnesota Climatology Working Group: http://climate.umn.edu/doc/prelim_lcd_msp.htm

IV. Applying IPM Principles and Concepts into Your Garden Design (Part Two)

A. The IPM Plan and the Garden Design

Example IPM Plans (Scenarios)

1. Plan #1: Whiteflies (insecticidal soap and sticky cards)
2. Plan #2: Whiteflies (trap crop, biocontrol, scouting & sticky cards)
3. Plan #3: Apple maggot (lite)
4. Plant #4: Apple maggot (aggressive)
5. Plan #5: Squash vine borer
6. Plan #6: Squash bugs
7. Plan #7: Cabbage butterflies
8. Plan #8: Spinach leafminer
9. Plan #9: Japanese beetle

Implications of using IPM in Growing Systems – Items for Discussion and Thinking
IPM and Organic Farming.
IPMSustainable Agriculture.
IPM and sustaining predator diversity in small areas and among soil-dwelling insects.
IPM Pollinator diversity among native bumblebees and solitary bees.
IPM and Residue-free Certification Programs.
Certified IPM Programs.

Assignment for Feb 18, 2012 – Your IPM Plan (Part 2)

Take a draft of your garden plan and/or design or brainstorm your garden design, and make adjustments to it based on the following process:

TARGET

1. Name the crop you plan to grow. _____

2. Identify the primary plant-feeding insect(s) you are concerned about for this plant. Use the scientific name, if known. Otherwise common names are OK.

_____ _____ _____

3. Select the life cycle stage(s) you are targeting. (See Timing section, if more information is needed.)

Adult[1] | Egg[2] | Young larva[2] | Mature larva[2] | Pupa[2] | Adult[2] | Other

TIMING

Go through the process of following the life cycle and key phenological events of your pest to determine when you will use your tools.

3. Generally, when does your insect of concern emerge as an **adult** in the spring?_____

3a. First emergence - Factsheet Estimate(s)_____ 3b. First emergence – Degree Day Estimate(s)_____

3c. Base temperature _____ 3d. Biofix_____

3e. Peak flight – Factsheet estimate(s)_____ 3f. Peak flight – Degree Day Estimate(s)_____

3g. Is the **adult** stage considered a viable target for a pest management plan?_____

4. Generally, when does your insect **lay eggs** after emerging as an adult?_____

4a. Egg lay – Factsheet estimate(s)_____ 4b. First egg lay – Degree Day Estimate(s)_____

4c. Number of days until eggs hatch_____ 4d. Degree days when eggs hatch_____

5. Generally, how many days/degree days does it take for your **immature form** to reach the pupal stage?

5a. From larva to pupal stage – Factheet estimate_____

5b. From larva to pupal stage – Degree day estimate _____

5c. Is your insect vulnerable during the larval stage? YES NO

6. Generally, how many days/degree days does your pest remain in the **pupal** stage?

6a. Time spent as pupa – Factsheet estimate _____

6b. Time spent as pupa – Degree Day estimate _____

6c. Is your pest vulnerable during the pupal stage? YES NO

7. Generally, how many degree days/degree days does your pest need to emerge as **a 2nd Gen. adult**?

7a. Days needed to emerge as 2d Gen adult – Factsheet estimate _____

7b. Days needed to emerge as a 2d Gen adult – Degree Day estimate _____

7c. Is the 2d generation adult a pest of concern? YES NO

TOOLS

List the tools you plan to use as part of your growing system. If they apply, try to include tools based on at least two (2) approaches in your plan—Cultural, Mechanical and Material, Biological, Chemical, and Monitoring and Trapping.

Tools for adult emergence: a. _____ b. _____ c. _____

Tools for egg lay: a. _____ b. _____ c. _____

Tools for larval stages: a. _____ b. _____ c. _____

Tools for pupal stages: a. _____ b. _____ c. _____

Tools for 2d Gen adults: a. _____ b. _____ c. _____

TECHNIQUE

Which of your TOOLS will you be "adjusting" to meet the specific needs of your growing area, plants, or system? Explain.*

a. _____

b. _____

c. _____

*Note that technique (aka, "technical adjustments") should not in any way be understood or interpreted to mean that a grower should use synthetic pesticides or other tools in ways that contradict the product label or manufacturer's recommendations.

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Other Sources on Pesticides

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Integrated Pest Management Ideas & Insect Life Cycle Information

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10. U of MN Insect Identification Tool: What Insect is This?. http://www.extension.umn.edu/gardeninfo/insectgallery/garden/index.html
11. The Ohio State University Insect Fact Sheet Series. http://ohioline.osu.edu/lines/pests.html
12. The Ohio State University Integrated Pest Management Pages.
13. IPM of Midwest Landscapes (U of M Publication). http://www.entomology.umn.edu/cues/ipmbook.htm
14. Insect Degree Day Calculator. http://www.soils.wisc.edu/asigServlets/asos/SelectDailyGridDD.jsp

Biological Control Suppliers

13. Green Methods. http://greenmethods.com/site/ (for biological control organisms)
14. Rincon Vitova Insectaries. http://www.rinconvitova.com/d-vac.htm (for biological control organisms)
15. Association of Natural Biocontrol Producers. http://www.anbp.org/members.htm

Suppliers of Integrated Pest Management Products

16. Great Lakes IPM. http://www.greatlakesipm.com/ (for IPM tools)
17. Arbico Organics. http://www.arbico-organics.com/ (for IPM tools & other gardening materials)

For consultation during the growing season:

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