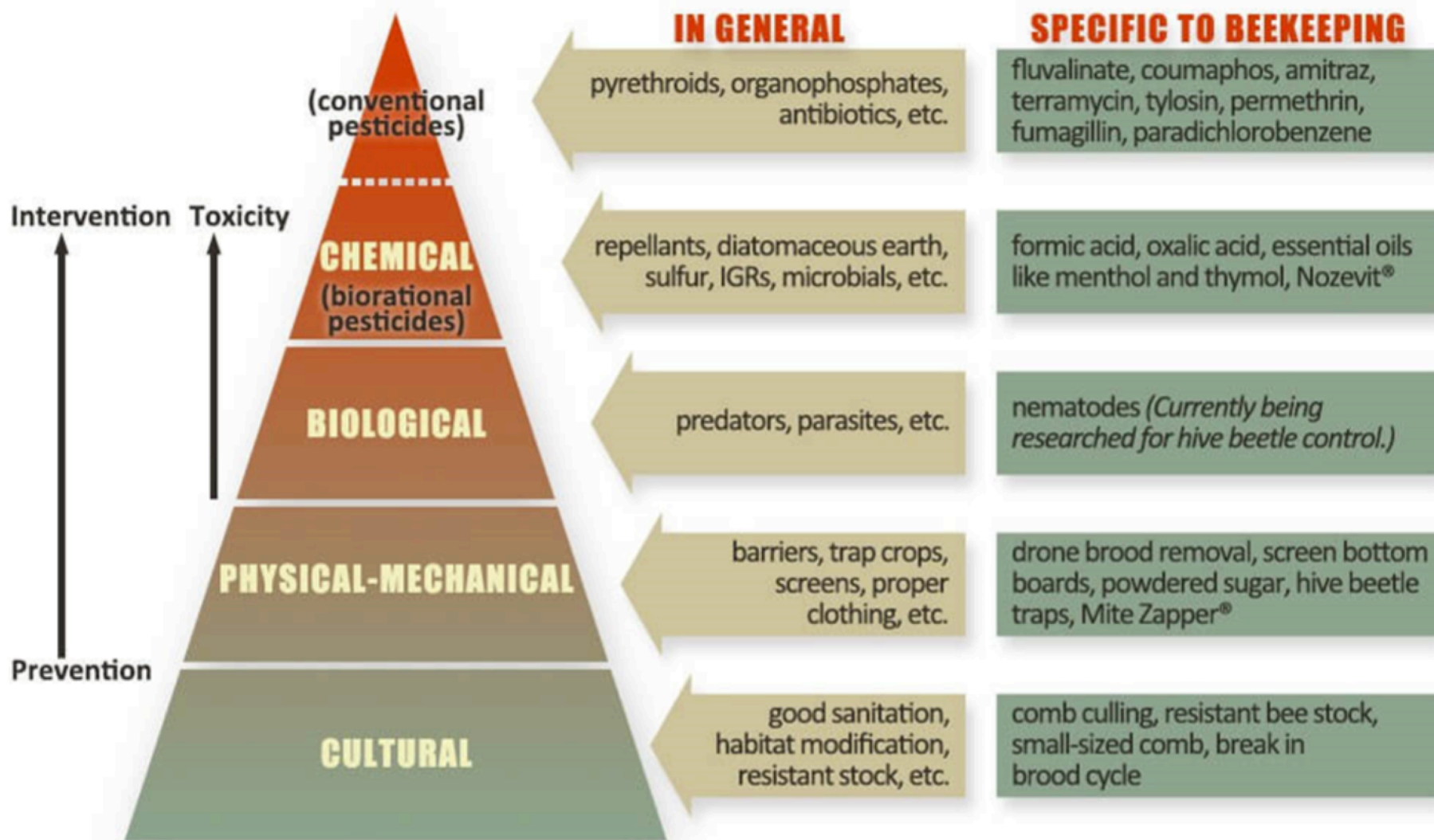


# The IPM Pyramid of Tactics

Frank Niccoli





# Pyramid of IPM Tactics

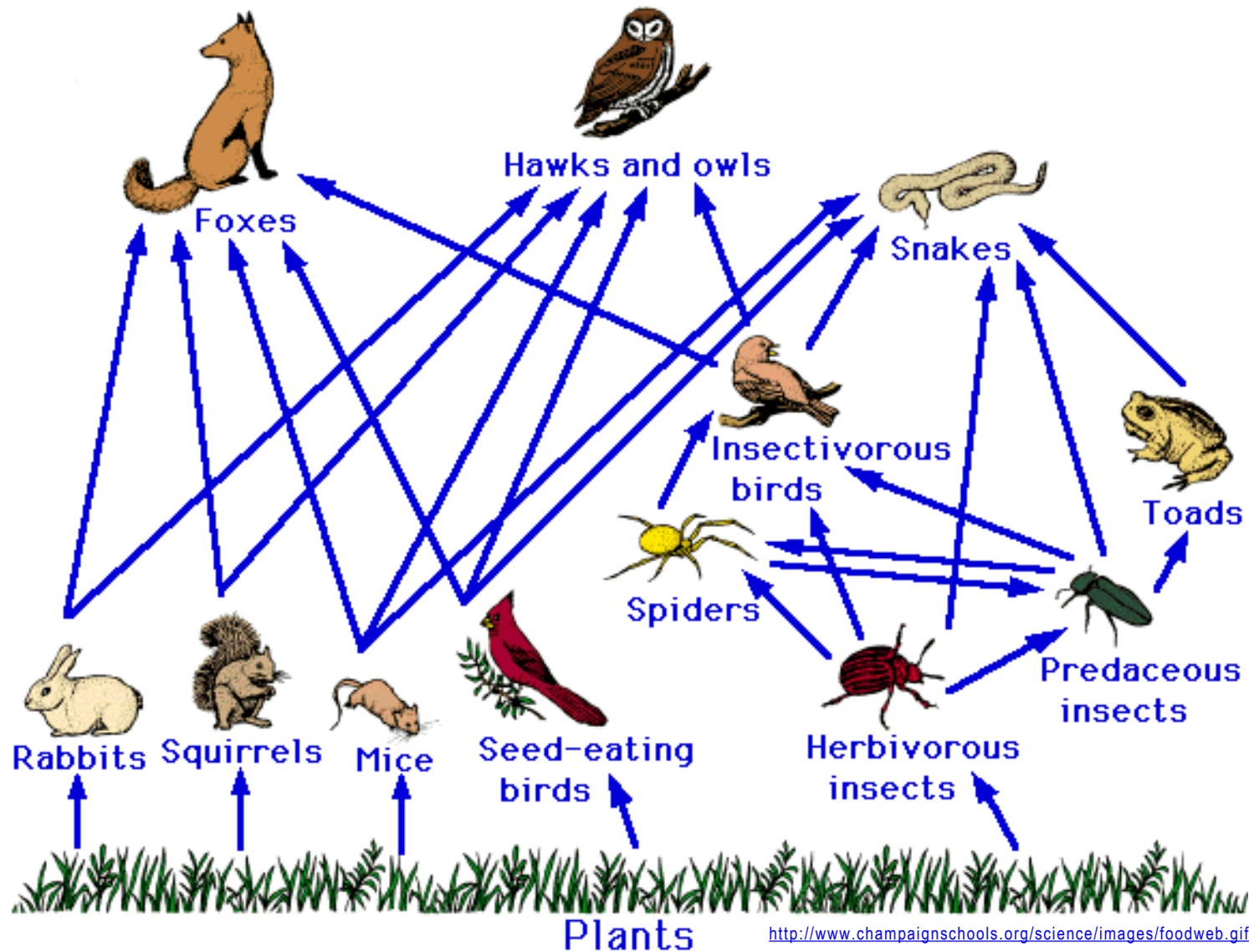


# What is a pest?



- An organism which has characteristics that are regarded by humans as injurious or unwanted
  - Eats a desired plant
  - Causes disease in a desired plant
  - Carries disease to a desired plant
- May be:
  - A vertebrate (deer; rabbit)
  - An insect/mollusk (snail)
  - A bacterium, virus or fungus
- A pest in one setting may be beneficial in another; like a weed, a pest may be an organism 'in the wrong place'

# Predator/prey relationships in nature



In nature, plants fight back...

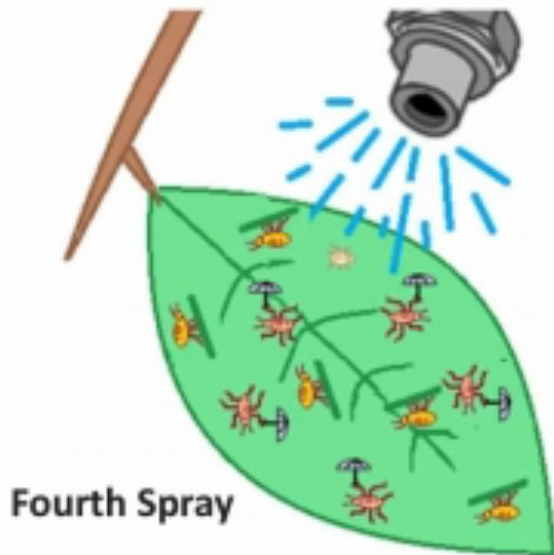












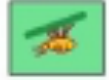
### Legend



Natural Enemy



Metabolic  
Resistant Insect



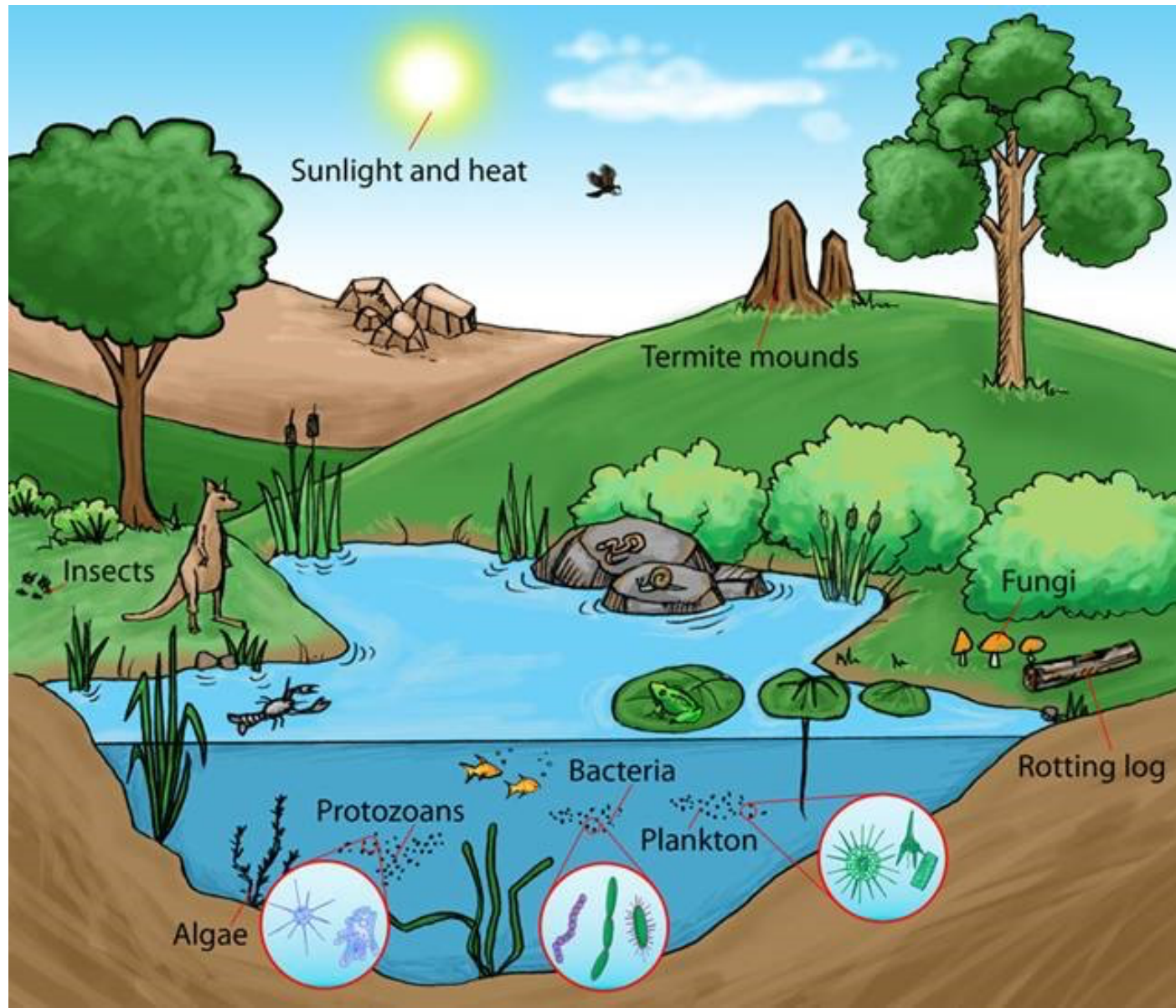
Behavioral  
Resistant Insect



Pest



# Plant an Ecosystem



# Planting natives reduces pesticide use in the garden





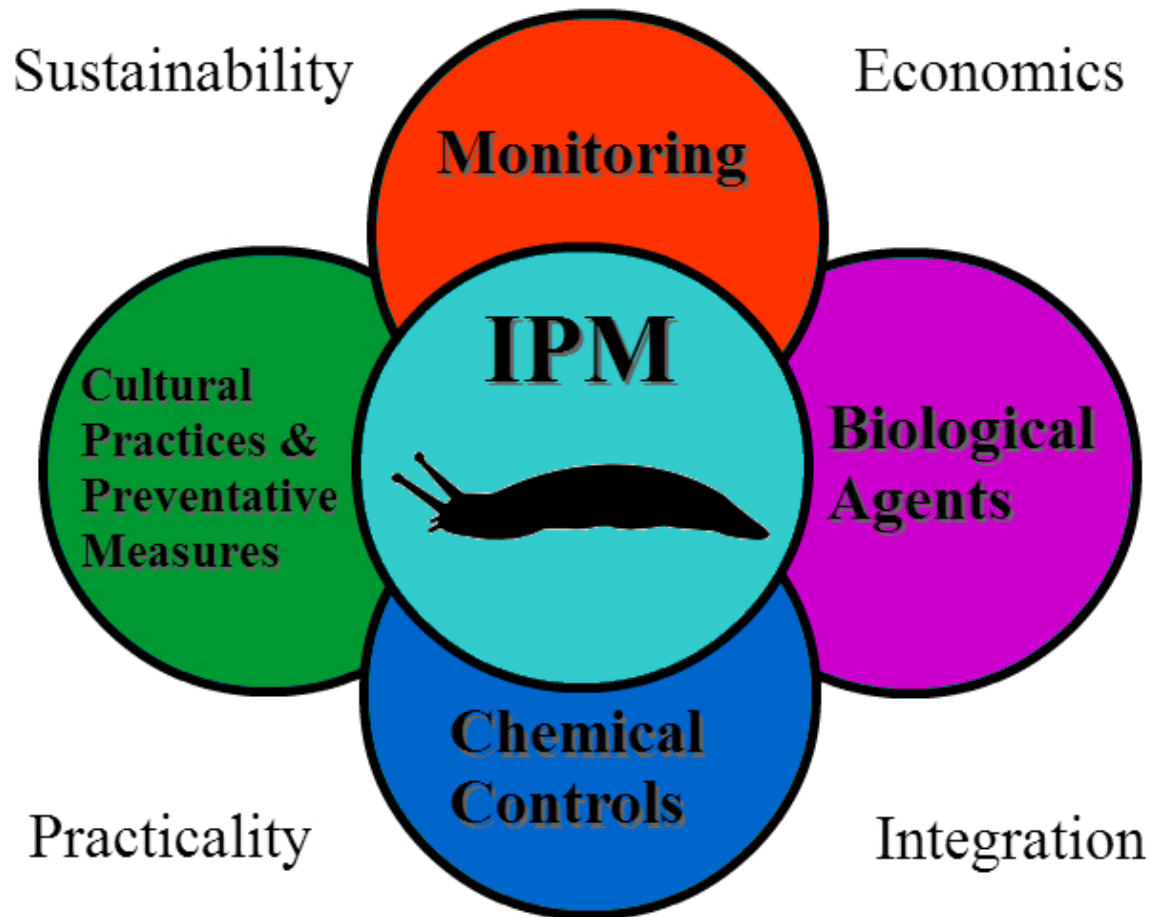
# The Strategy



And that's where the concept of Integrated Pest Management (IPM) provides useful guidelines



# What is Integrated Pest Management (IPM)



# WHAT DOES IT ACTUALLY MEAN ?



## INTEGRATED PEST MANAGEMENT



### INTEGRATED

Composed of separate parts united together to form a more complete & compatible unit

### PEST

An organism that reduces the availability, quality, or value of some natural resource

### MANAGEMENT

Skilled handling



- Use the least invasive - and often most effective - means first:
  - Prevention - cultural practices
  - Mechanical Controls
  - Naturally occurring biological controls (native predators)
- Consider using non-native predators
- Use chemical controls sparingly, as a last resort:
  - Naturally occurring elements
  - Biologics - chemicals made by plants that are toxic to pests/diseases
  - Non-biologic pesticides:
    - Insecticides
    - Fungicides
    - Miticides



What are the Benefits?

# Integrated Pest Management (IPM)



# IPM is based on six basic components

**Set Action Thresholds**

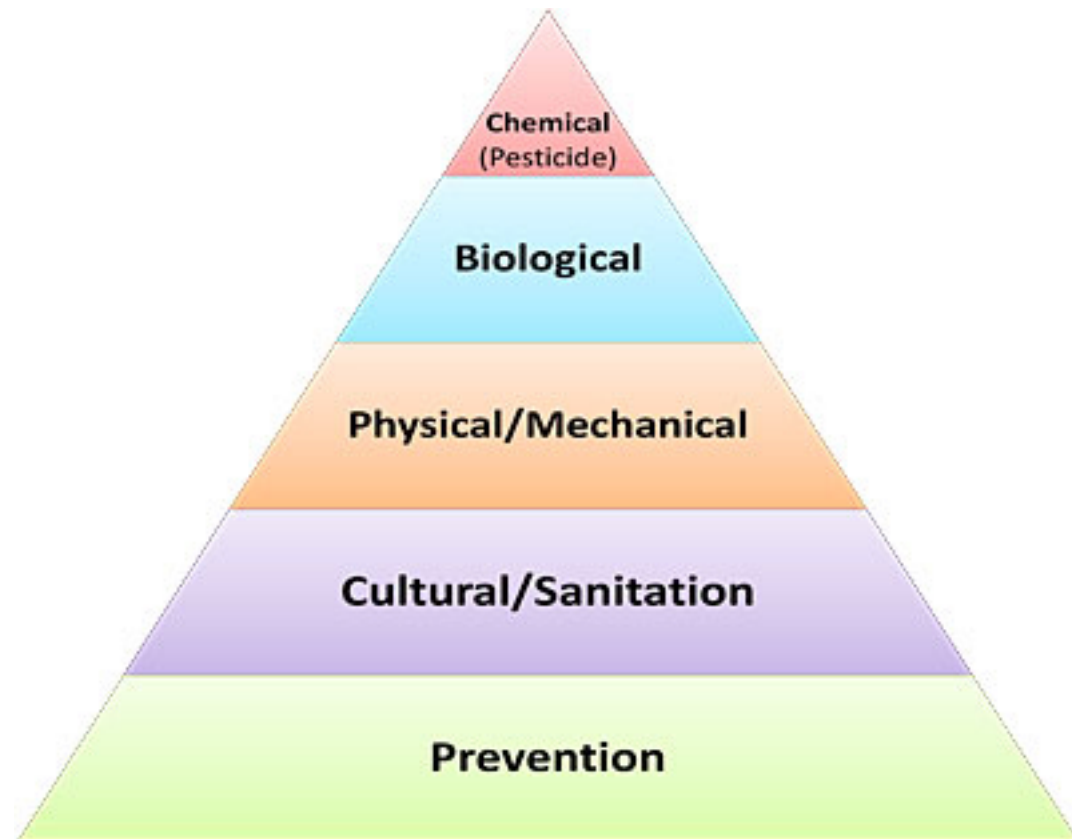
**Monitor and Identify Pests**

**Preventive Cultural Practices**

**Mechanical Methods**

**Biological Controls**

**Chemical Controls**



# IPM is based on six basic components

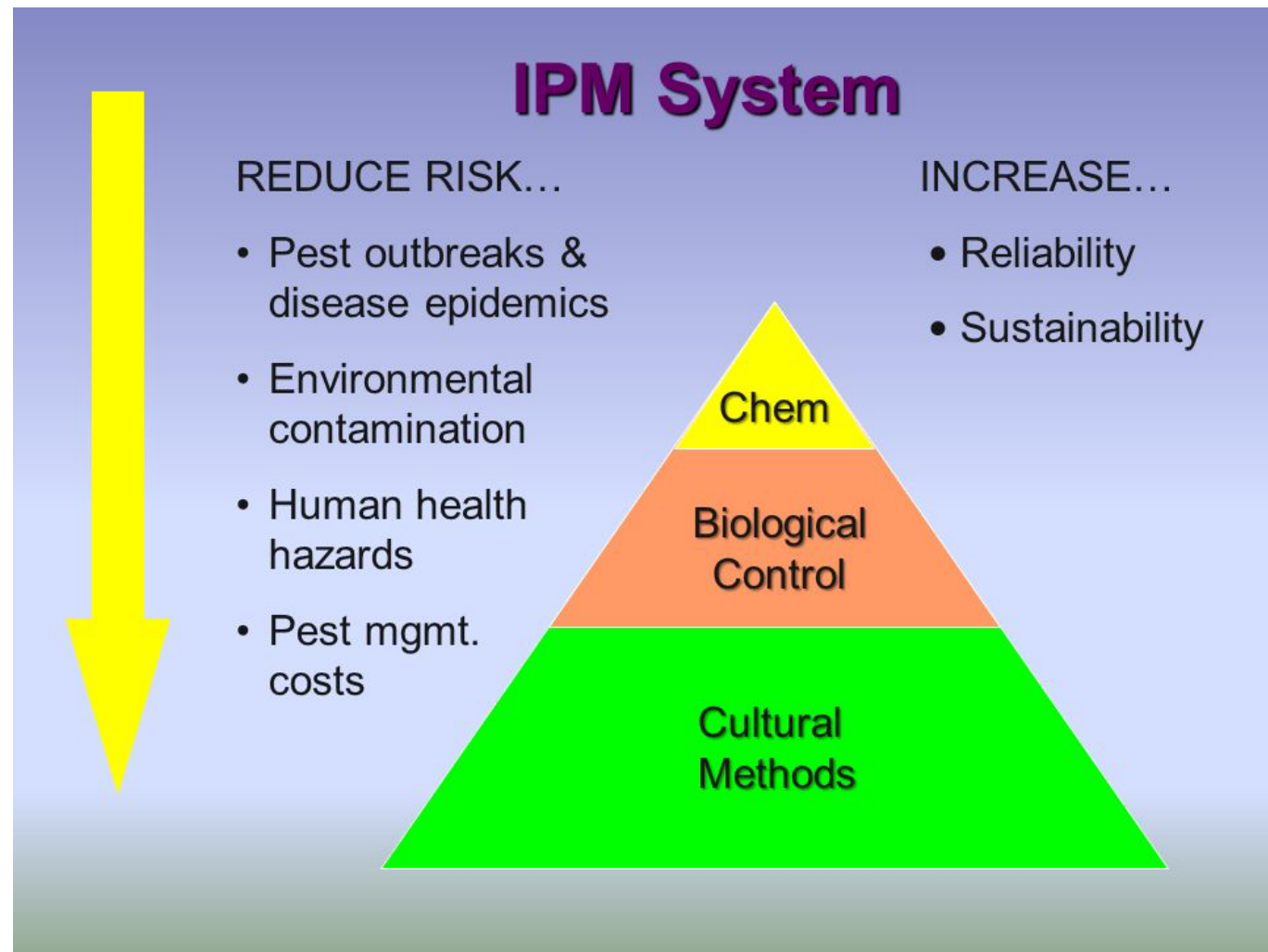
## Set Action Thresholds





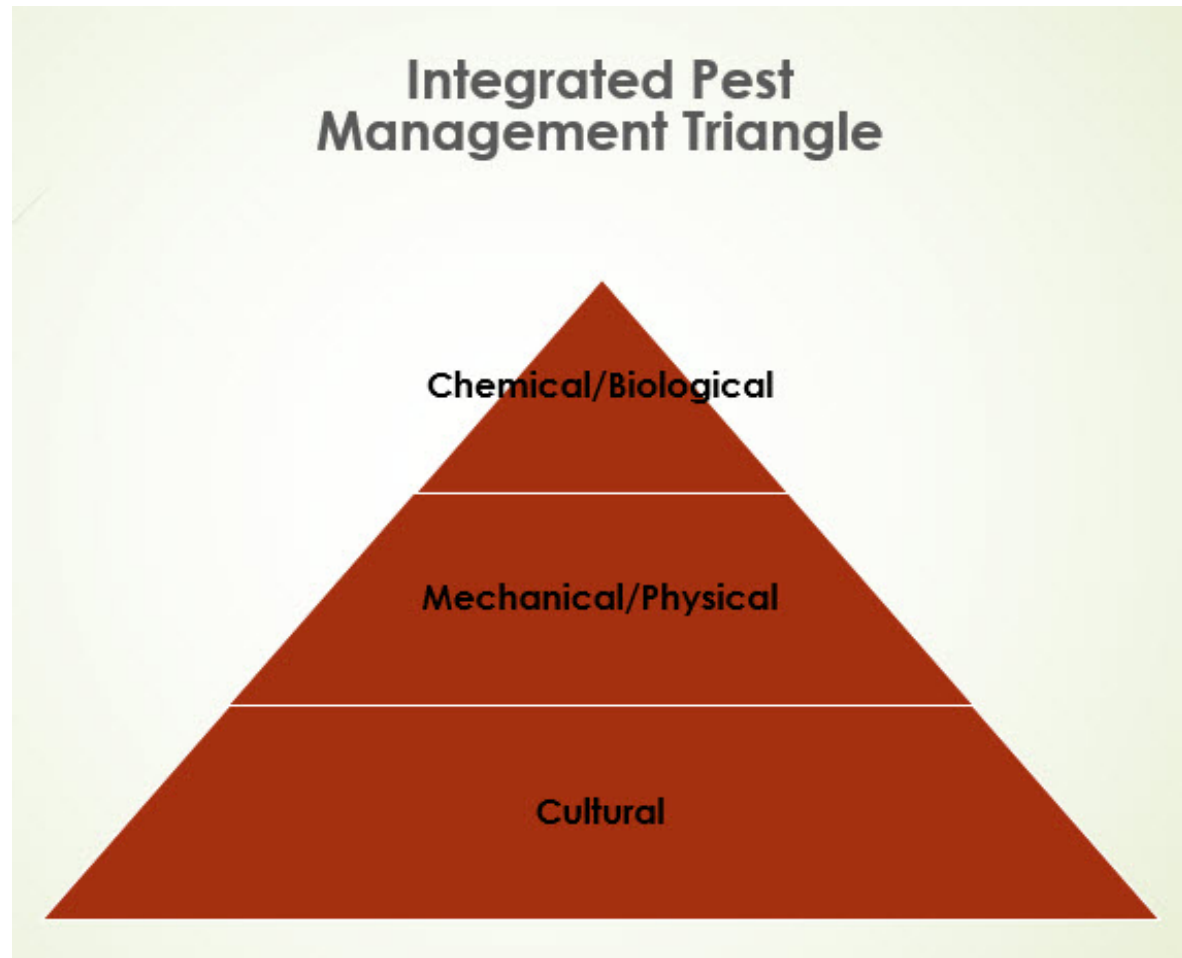
# IPM is based on six basic components

## Preventive Cultural Practices



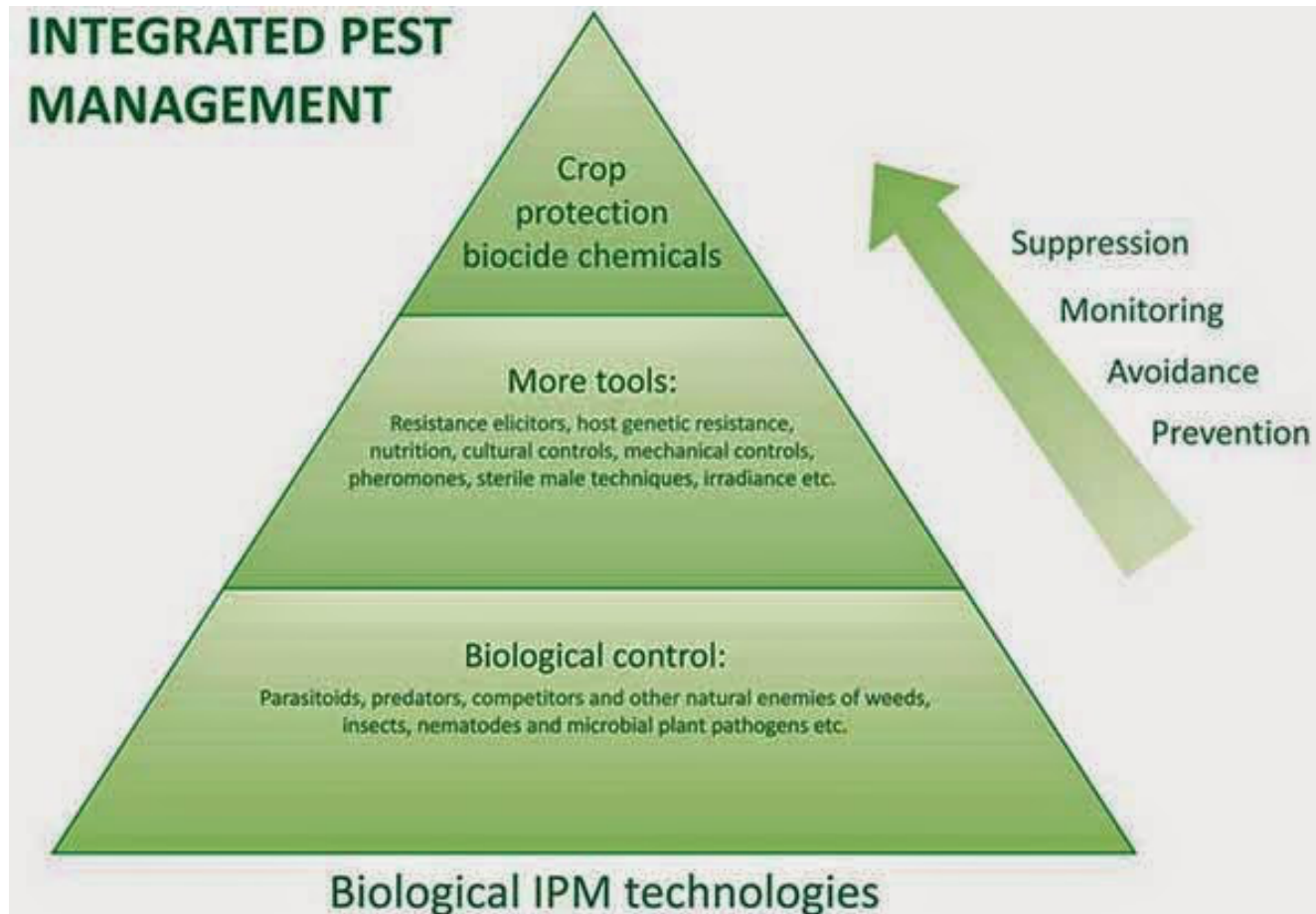
# IPM is based on six basic components

## Physical or Mechanical Methods



# IPM is based on six basic components

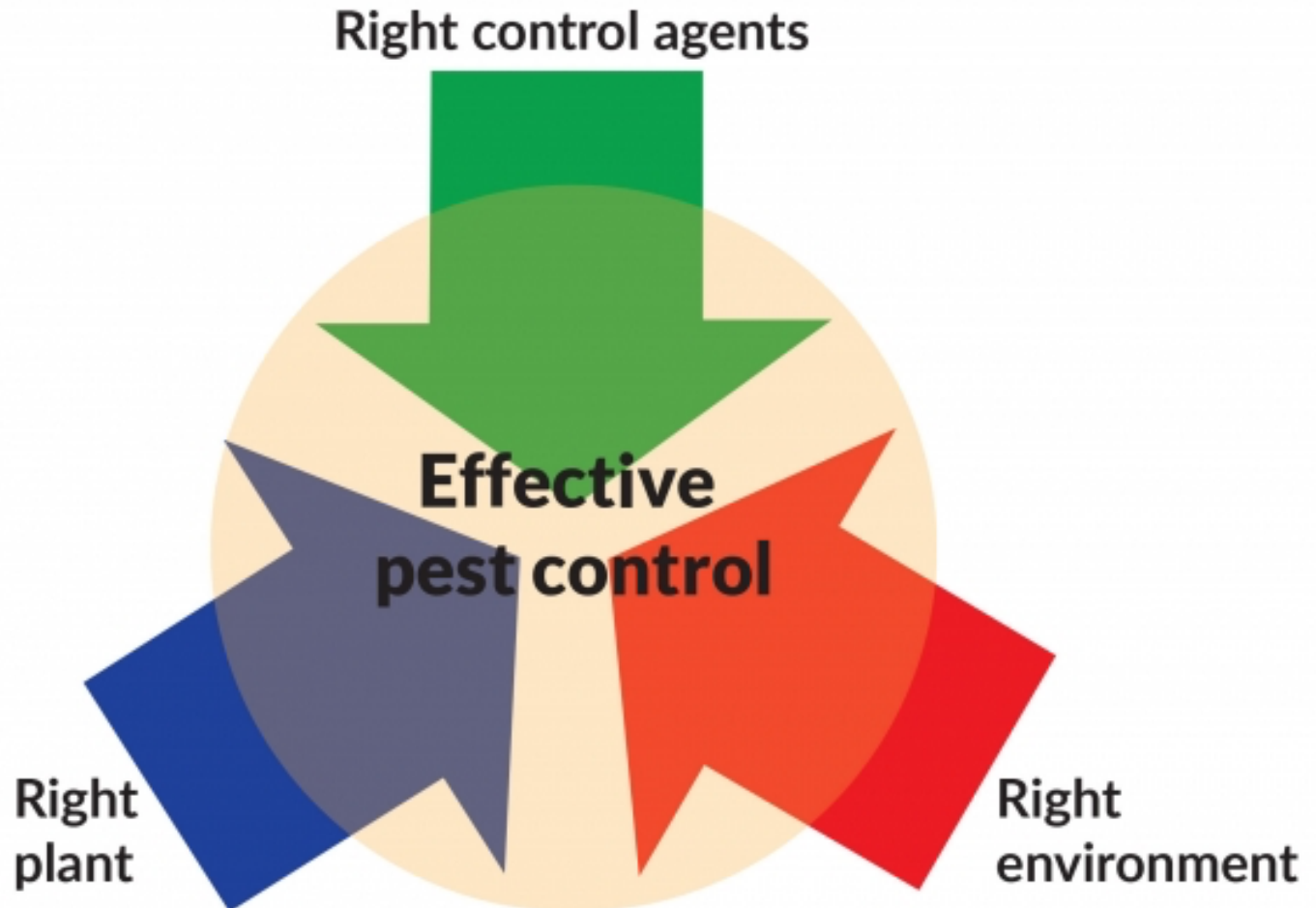
## Biological Controls





# IPM is based on six basic components

## Chemical Controls



# An IPM System is a Moving Target



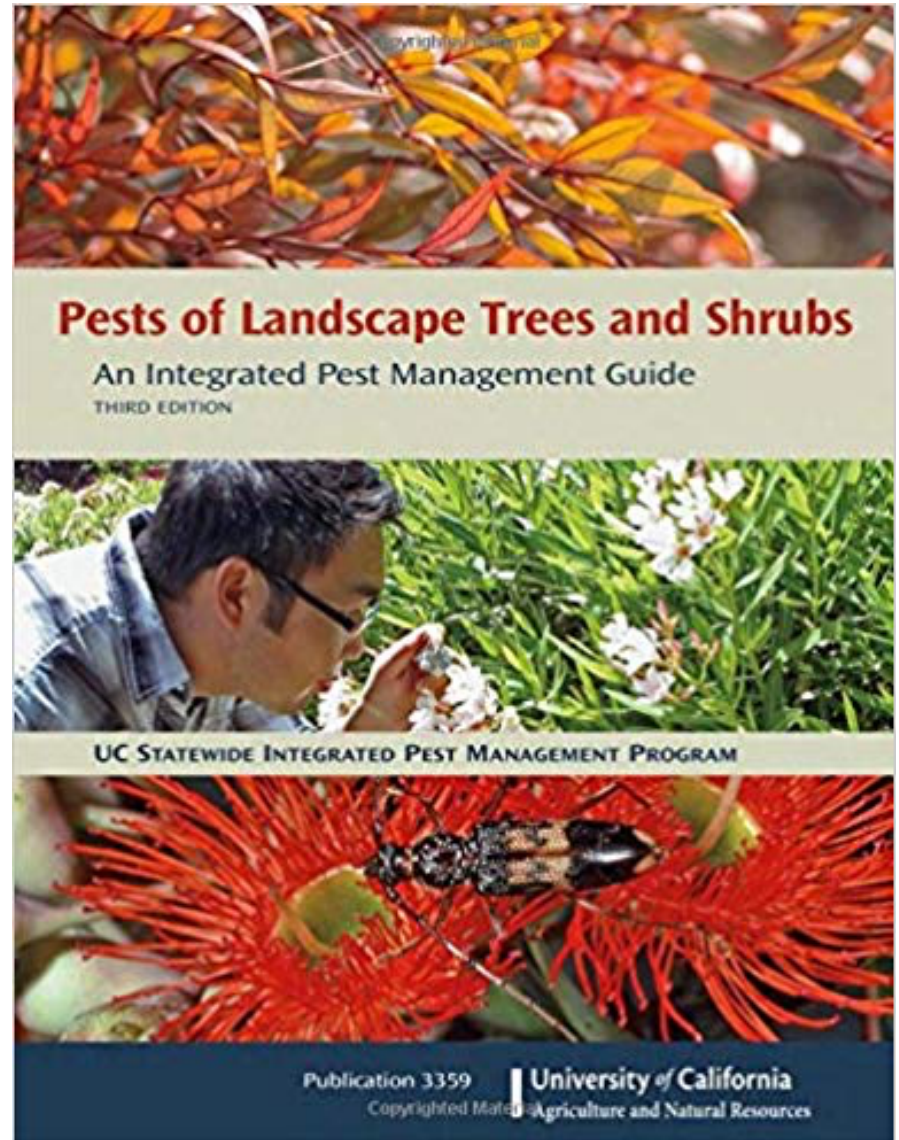
- Requires observation & knowledge – specific for your garden
- Will vary somewhat with:
  - Yearly weather conditions
  - Maturity of plants
  - New plants
- Will be modified based on your previous experiences
- Suggestion: keep a garden notebook/journal

# Resources





# Resources



# Resources



# Resources

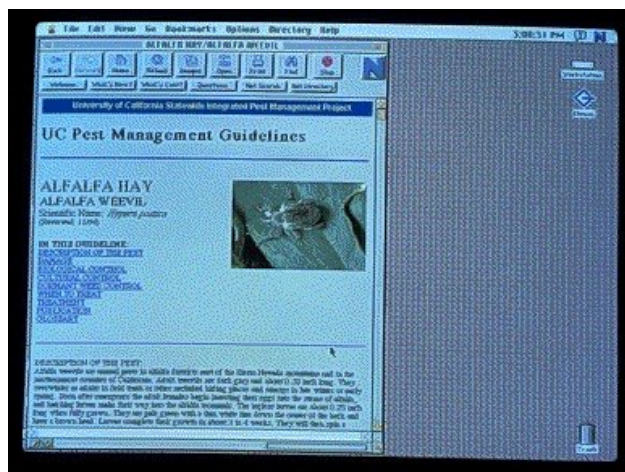






# University of California Statewide IPM Project (UCIPM)

- Goals of the IPM Project are to:
  - reduce the pesticide load in the environment,
  - increase the predictability and thereby the effectiveness of pest control techniques,
  - develop pest control programs that are economically, environmentally and socially acceptable,
  - marshal agencies and disciplines into integrated pest management program, and
  - increase the utilization of natural pest controls.
- Educational component:
  - Print & on-line resources
  - UC IPM Pesticide Education Program



# Set Pest Level Thresholds



- Find out what pests/ diseases occur in your garden - observation
- Learn more about the pests, their effects
  - What are their life-stages
  - What seasons/conditions are they associated with
  - What plant species are susceptible
- Learn how to determine when action should be taken



# Monitor & Identify Pests



## Sticky Trap Monitoring of Insect Pests

**CLINICAL RELEVANCE**

**Source:** *Journal of Interpersonal Violence*, 2006, 21(12), 1569-1581.

**INDEX**

**Journal of Applied Gerontology** 42(2): 129-140

S. J. GARDNER &amp; S. HIGGINS

Copyright © 2006 by John Wiley & Sons, Inc.

**S**olving today's problems means knowing what's at stake, finding solutions, steps and obstacles. The publication is a practical guide to solving any project, involving cost management, risk and developing control and discipline. Although the document is broader, it includes a number of practical guidelines, giving an overview of some common, but often not shared, information that can be useful.

1998-1999, 2000-2001, 2002-2003, 2004-2005, 2006-2007, 2008-2009, 2010-2011, 2012-2013, 2014-2015, 2016-2017, 2018-2019, 2020-2021, 2022-2023, 2024-2025, 2026-2027, 2028-2029, 2030-2031, 2032-2033, 2034-2035, 2036-2037, 2038-2039, 2040-2041, 2042-2043, 2044-2045, 2046-2047, 2048-2049, 2050-2051, 2052-2053, 2054-2055, 2056-2057, 2058-2059, 2060-2061, 2062-2063, 2064-2065, 2066-2067, 2068-2069, 2070-2071, 2072-2073, 2074-2075, 2076-2077, 2078-2079, 2080-2081, 2082-2083, 2084-2085, 2086-2087, 2088-2089, 2090-2091, 2092-2093, 2094-2095, 2096-2097, 2098-2099, 2100-2101, 2102-2103, 2104-2105, 2106-2107, 2108-2109, 2110-2111, 2112-2113, 2114-2115, 2116-2117, 2118-2119, 2120-2121, 2122-2123, 2124-2125, 2126-2127, 2128-2129, 2130-2131, 2132-2133, 2134-2135, 2136-2137, 2138-2139, 2140-2141, 2142-2143, 2144-2145, 2146-2147, 2148-2149, 2150-2151, 2152-2153, 2154-2155, 2156-2157, 2158-2159, 2160-2161, 2162-2163, 2164-2165, 2166-2167, 2168-2169, 2170-2171, 2172-2173, 2174-2175, 2176-2177, 2178-2179, 2180-2181, 2182-2183, 2184-2185, 2186-2187, 2188-2189, 2190-2191, 2192-2193, 2194-2195, 2196-2197, 2198-2199, 2200-2201, 2202-2203, 2204-2205, 2206-2207, 2208-2209, 2210-2211, 2212-2213, 2214-2215, 2216-2217, 2218-2219, 2220-2221, 2222-2223, 2224-2225, 2226-2227, 2228-2229, 2230-2231, 2232-2233, 2234-2235, 2236-2237, 2238-2239, 2240-2241, 2242-2243, 2244-2245, 2246-2247, 2248-2249, 2250-2251, 2252-2253, 2254-2255, 2256-2257, 2258-2259, 2260-2261, 2262-2263, 2264-2265, 2266-2267, 2268-2269, 2270-2271, 2272-2273, 2274-2275, 2276-2277, 2278-2279, 2280-2281, 2282-2283, 2284-2285, 2286-2287, 2288-2289, 2290-2291, 2292-2293, 2294-2295, 2296-2297, 2298-2299, 2300-2301, 2302-2303, 2304-2305, 2306-2307, 2308-2309, 2310-2311, 2312-2313, 2314-2315, 2316-2317, 2318-2319, 2320-2321, 2322-2323, 2324-2325, 2326-2327, 2328-2329, 2330-2331, 2332-2333, 2334-2335, 2336-2337, 2338-2339, 2340-2341, 2342-2343, 2344-2345, 2346-2347, 2348-2349, 2350-2351, 2352-2353, 2354-2355, 2356-2357, 2358-2359, 2360-2361, 2362-2363, 2364-2365, 2366-2367, 2368-2369, 2370-2371, 2372-2373, 2374-2375, 2376-2377, 2378-2379, 2380-2381, 2382-2383, 2384-2385, 2386-2387, 2388-2389, 2390-2391, 2392-2393, 2394-2395, 2396-2397, 2398-2399, 2400-2401, 2402-2403, 2404-2405, 2406-2407, 2408-2409, 2410-2411, 2412-2413, 2414-2415, 2416-2417, 2418-2419, 2420-2421, 2422-2423, 2424-2425, 2426-2427, 2428-2429, 2430-2431, 2432-2433, 2434-2435, 2436-2437, 2438-2439, 2440-2441, 2442-2443, 2444-2445, 2446-2447, 2448-2449, 2450-2451, 2452-2453, 2454-2455, 2456-2457, 2458-2459, 2460-2461, 2462-2463, 2464-2465, 2466-2467, 2468-2469, 2470-2471, 2472-2473, 2474-2475, 2476-2477, 2478-2479, 2480-2481, 2482-2483, 2484-2485, 2486-2487, 2488-2489, 2490-2491, 2492-2493, 2494-2495, 2496-2497, 2498-2499, 2500-2501, 2502-2503, 2504-2505, 2506-2507, 2508-2509, 2510-2511, 2512-2513, 2514-2515, 2516-2517, 2518-2519, 2520-2521, 2522-2523, 2524-2525, 2526-2527, 2528-2529, 2530-2531, 2532-2533, 2534-2535, 2536-2537, 2538-2539, 2540-2541, 2542-2543, 2544-2545, 2546-2547, 2548-2549, 2550-2551, 2552-2553, 2554-2555, 2556-2557, 2558-2559, 2560-2561, 2562-2563, 2564-2565, 2566-2567, 2568-2569, 2570-2571, 2572-2573, 2574-2575, 2576-2577, 2578-2579, 2580-2581, 2582-2583, 2584-2585, 2586-2587, 2588-2589, 2590-2591, 2592-2593, 2594-2595, 2596-2597, 2598-2599, 2600-2601, 2602-2603, 2604-2605, 2606-2607, 2608-2609, 2610-2611, 2612-2613, 2614-2615, 2616-2617, 2618-2619, 2620-2621, 2622-2623, 2624-2625, 2626-2627, 2628-2629, 2630-2631, 2632-2633, 2634-2635, 2636-2637, 2638-2639, 2640-2641, 2642-2643, 2644-2645, 2646-2647, 2648-2649, 2650-2651, 2652-2653, 2654-2655, 2656-2657, 2658-2659, 2660-2661, 2662-2663, 2664-2665, 2666-2667, 2668-2669, 2670-2671, 2672-2673, 2674-2675, 2676-2677, 2678-2679, 2680-2681, 2682-2683, 2684-2685, 2686-2687, 2688-2689, 2690-2691, 2692-2693, 2694-2695, 2696-2697, 2698-2699, 2700-2701, 2702-2703, 2704-2705, 2706-2707, 2708-2709, 2710-2711, 2712-2713, 2714-2715, 2716-2717, 2718-2719, 2720-2721, 2722-2723, 2724-2725, 2726-2727, 2728-2729, 2730-2731, 2732-2733, 2734-2735, 2736-2737, 2738-2739, 2740-2741, 27

King, another key figure in post-genocide, has given—and been given—praise and criticism, and is also generally recognized as having a strong history in management of the genocide. In what ways might his management style have been an advantage to the nation and to those in charge of managing the genocide? Consider that the King was a Christian and a member of the United Methodist Church. How might his religious beliefs have influenced his management style? Consider the King's role in the genocide, his role in the management of the genocide, and his role in the management of the genocide.

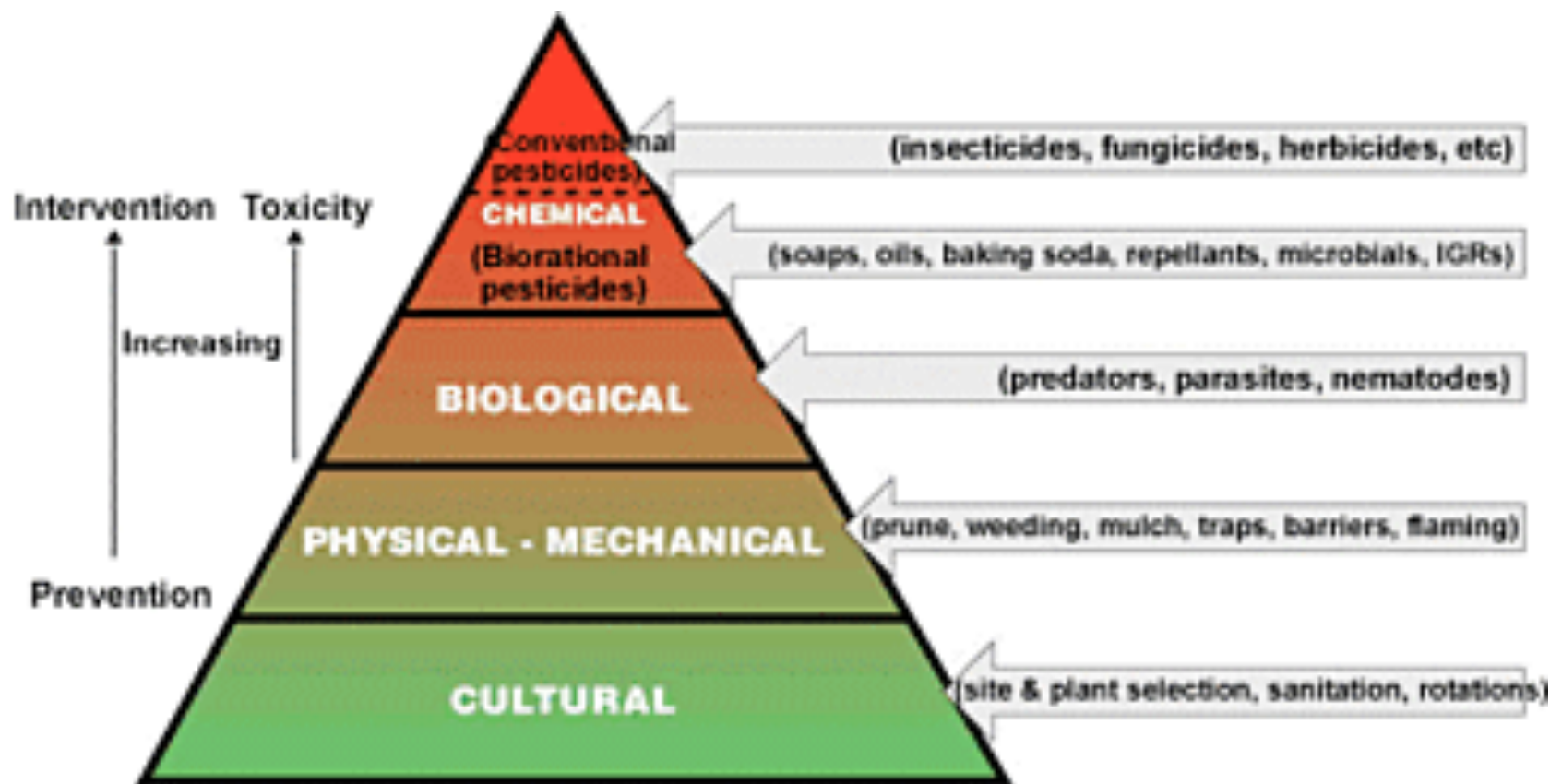
Studies using animal and genetically engineered model systems have demonstrated the benefit of feeding of treatment supplements. These have been used to combat malnutrition-related consequences of famine and other emergency conditions in different studies (1, 14, 17, 18), and other nutritional aspects of acute shock. The benefit of feeding is not yet clear, requiring more long-term studies of emergency feeding programs. There are some good data on short-term effects on clinical outcomes in severely malnourished children in the presence of acute illness, however, not the observed

Institute of Agriculture  
 Division of Agriculture and Natural Resources  
 Publication 20171





# Prevention/Cultural Practices



## Pyramid of IPM Tactics

### *Plants*

# Selecting the **Right** treatment

Least Hazardous to Human Health



# Selecting the **Right** treatment

Least Disruptive of Natural Controls



# Selecting the **Right** treatment

Least Toxic to Non-Target Organisms





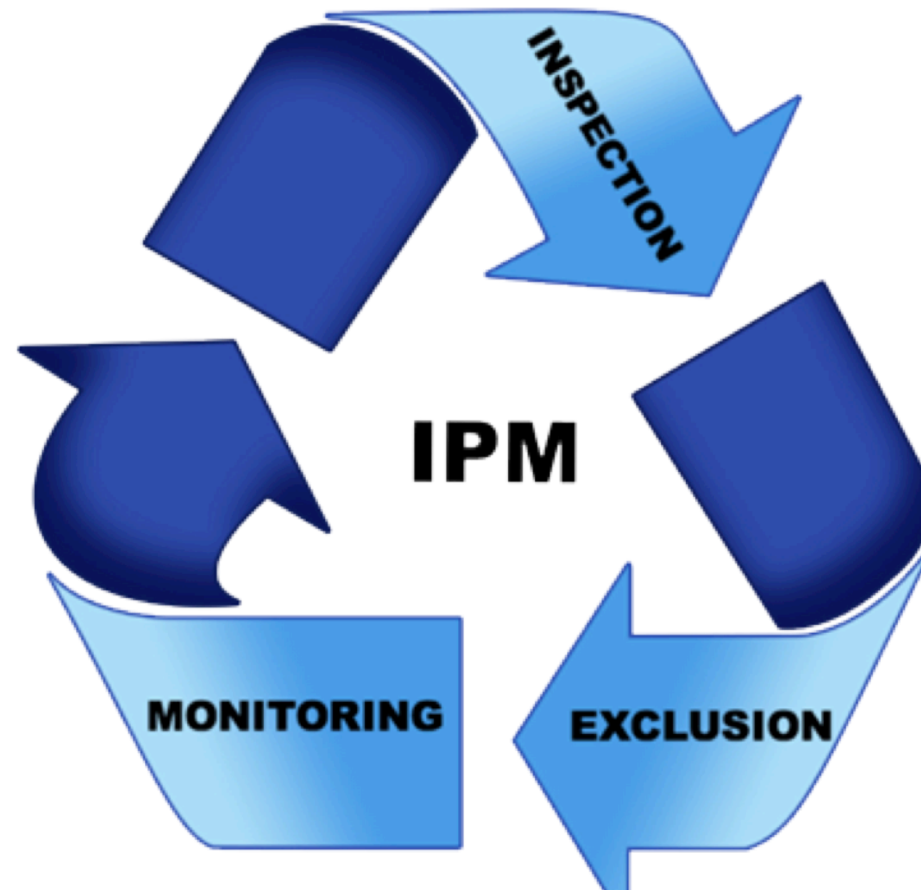
# Selecting the **Right** treatment

Treatment Closest to a Permanent Solution



# Selecting the **Right** treatment

Easiest to Implement Safely and Effectively

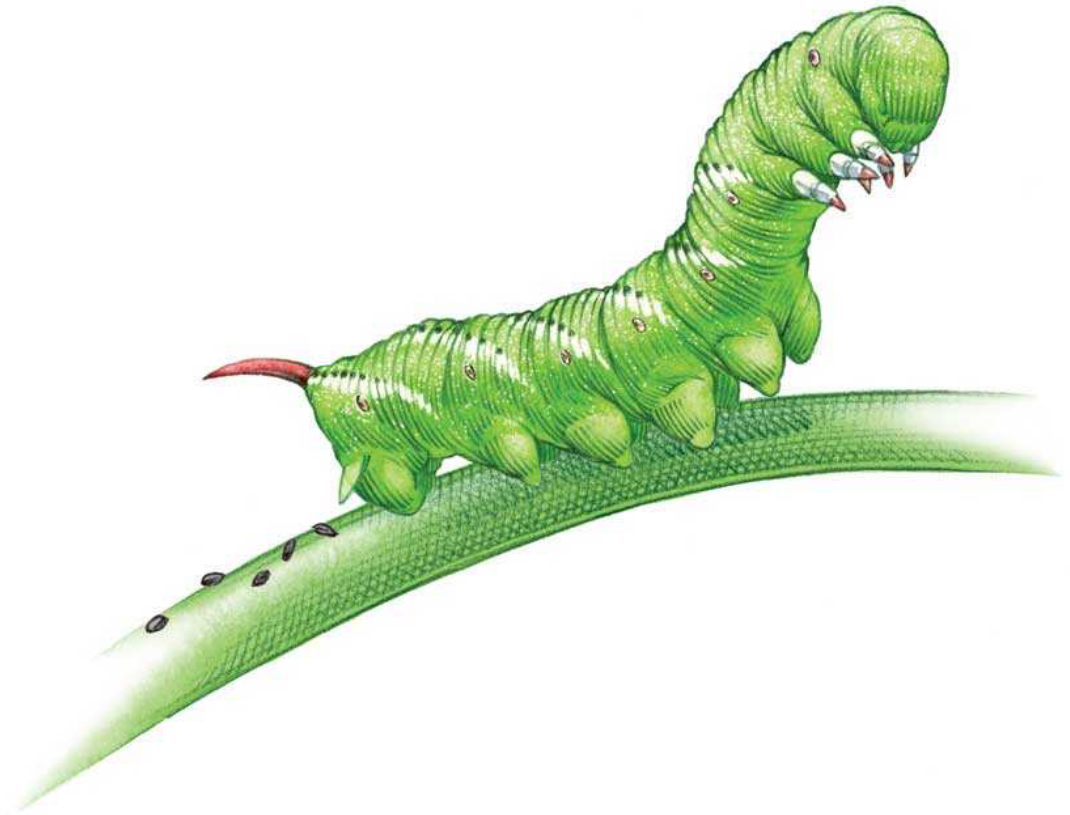


# Selecting the **Right** treatment

## 1. Best Site-Appropriate Solution



# Seasonal Challenges with Pest Control







# Sucking insects

Insects that insert their mouthparts into the carbohydrate rich phloem and suck out the nutrients.



# New Foliage Can Attract Suckers





# Aphids are Krill



# Aphids





# Whiteflies



# Monitor Susceptible Plants





# Mealybugs





# Sooty Mold





# True Bugs



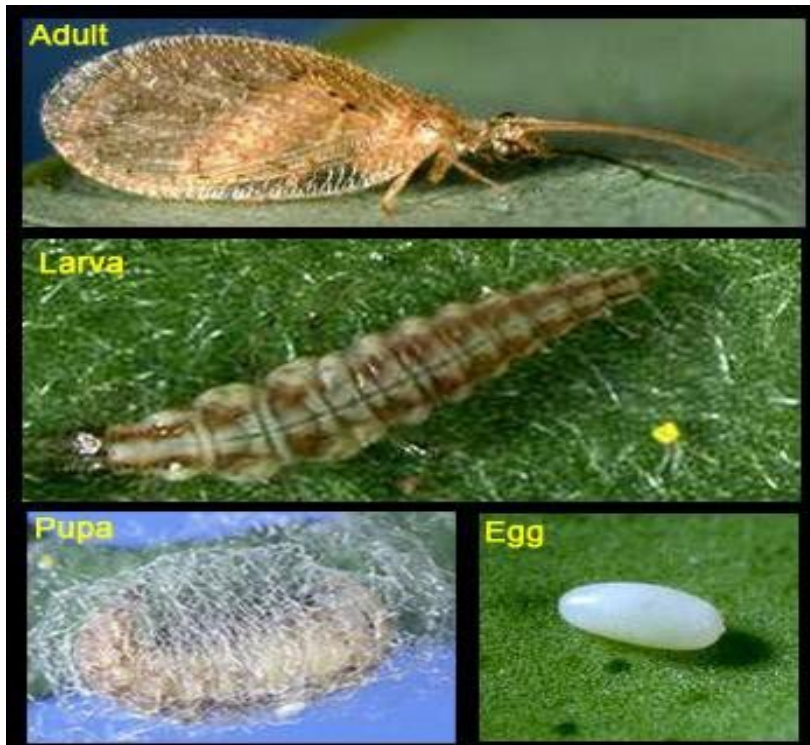
# Lacewings



Attract these beneficial insects	By planting these species
Bigeyed bug	Native grasses <i>Polygonum</i> sp. (Silver Lace Vine)
Hoverflies	<i>Achillea</i> sp. (Yarrow) <i>Asclepias fascicularis</i> (Narrowleaf Milkweed) <i>Baccharis</i> sp. (Coyote brush, Mulefat) <i>Ceanothus</i> sp. (California Lilac) <i>Eriogonum</i> sp. (Buckwheat) <i>Prunus ilicifolia</i> (Hollyleaf Cherry)
Lacewings	<i>Ceanothus</i> sp. (California Lilac) <i>Prunus ilicifolia</i> (Hollyleaf Cherry)
Lady beetles	<i>Achillea</i> sp. (Yarrow) <i>Asclepias fascicularis</i> (Narrowleaf Milkweed) <i>Atriplex</i> sp. (Quailbush, Saltbush) <i>Ceanothus</i> sp. (California Lilac) Native grasses <i>Rhamnus californica</i> (Coffeeberry) <i>Salix</i> sp. (Willow)



# Know the Life Cycles of Beneficial Insects





Attract these beneficial insects	By planting these species
Minute pirate bug	<i>Achillea</i> sp. (Yarrow) <i>Baccharis</i> sp. (Coyote brush, Mulefat) <i>Eriogonum</i> sp. (Buckwheat)
Parasitic & Predatory Wasps	<i>Achillea</i> sp. (Yarrow) <i>Aesclepias fascicularis</i> (Narrowleaf Milkweed) <i>Eriogonum</i> sp. (Buckwheat)
Tachnid flies	<i>Achillea</i> sp. (Yarrow) <i>Eriogonum</i> sp. (Buckwheat) <i>Heteromeles arbutifolia</i> (Toyon)  <i>Rhamnus californica</i> (Coffeeberry)

# Levels of Control

1. **Cultural control** is a preventative measure using fertilization, plant selection, and sanitation to exclude problematic pests and weeds.
2. **Physical control** is another preventative strategy. It includes, pest exclusion; creating barriers; modifying conditions such as temperature, light and humidity; trapping; and manually weeding. Foods and beverages should be eaten and stored only in designated areas.
3. **Biological control** makes use of a pest's natural enemies. This strategy introduces beneficial insects or bacteria to the environment or, if they already exist, provides them with the necessary food and shelter and avoids using broad-spectrum chemicals that will inadvertently kill them.
4. **Chemical control** is used after all other control strategies are deemed inappropriate or ineffective. Target-specific, low-toxicity pesticides should be applied in a manner that will maximize the effectiveness of pest management and minimize the exposure to humans and other non-target species. Spot treat if possible to reduce exposure.

# Smother the Mother!



# Smother the Mother!





# Natives



# Pests of Rose Family





# Leafhoppers & Sharpshooters





# Leafhoppers & Sharpshooters



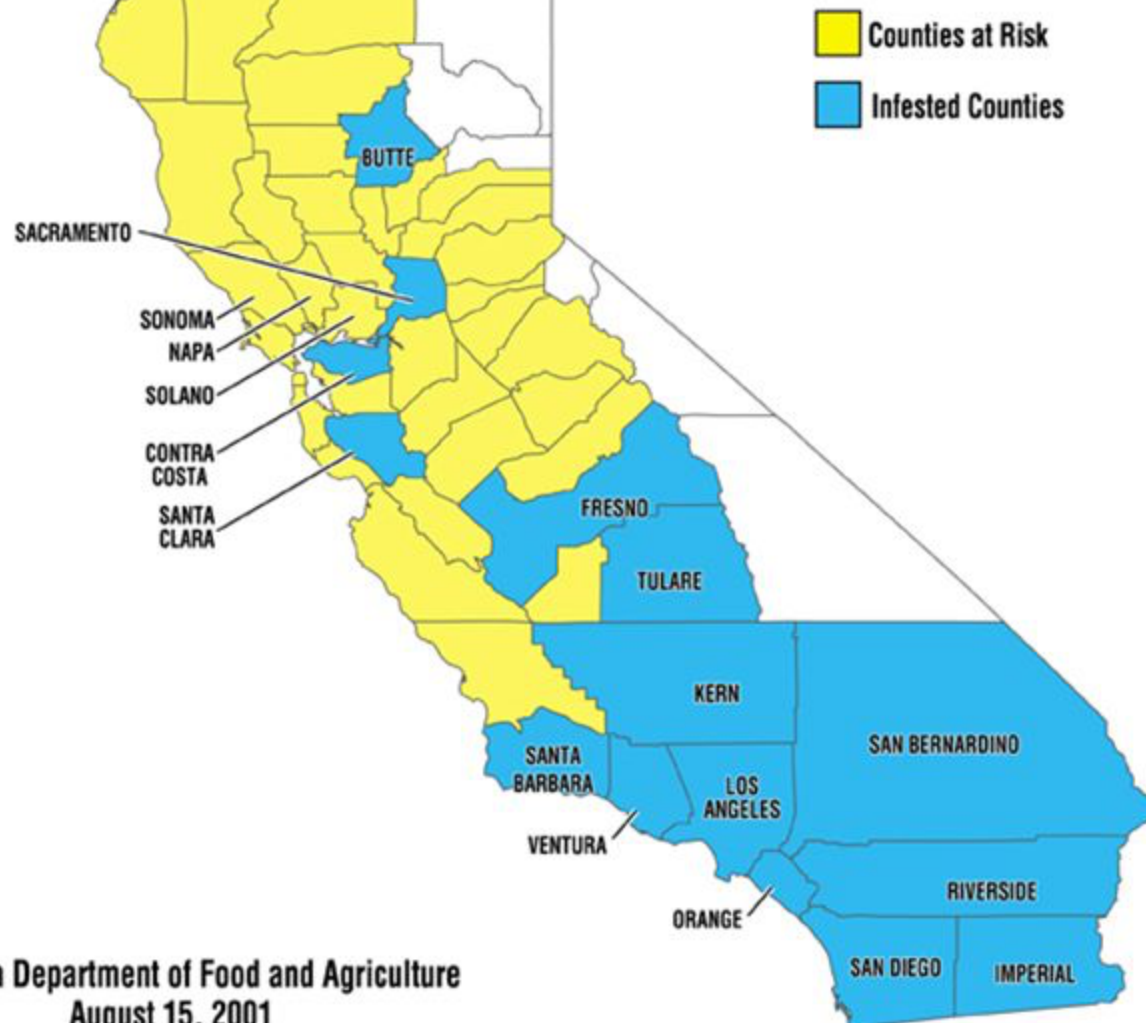
# Glassy-winged Sharpshooter

reportable pest



*Cynthia Bingham Keiser*

## DISTRIBUTION OF GWSS IN CALIFORNIA



California Department of Food and Agriculture  
August 15, 2001



# Pierce's Disease: Native Plants are the Alternate Hosts





# Thrips



# Thrips





# Gall & Blister Mites



# Spider Mites





# Spider Mites





# Chewing Insects



# Sucking or a Chewing Pest?



# Botanical pesticides: natural but not harmless for control of chewing insects

- **Pyrethrum** is extracted from the flowers of a chrysanthemum grown in Kenya and Ecuador. It is one of the oldest and safest insecticides available.
  - Mode of action — Pyrethrum (and synthetic pyrethrum) paralyze insect's nervous system.
  - Used for - aphids, scale insects, spider mites, thrips, caterpillars and many other leaf-feeding pests
- **Rotenone** or rotenoids are produced in the roots of two genera of the legume family: *Derris* and *Lonchocarpus* (also called cubé) grown in South America.
  - Mode of action: shuts down cellular metabolism
  - It is both a stomach and contact insecticide; toxic to many species of insects in many different insect orders (caterpillars, beetles, flies, etc.).
  - Mild human toxicity; ? Risk for Parkinson's Disease
- **Eugenol** (Oil of Cloves) and **Cinnamaldehyde** (derived from Ceylon and Chinese cinnamon oils).
  - Mode of action - similar to Pyrethrum
  - Used for: chewing insects like beetles - but general insecticide
- **Nicotine** is extracted by several methods from tobacco
  - Mode of action - nervous system conduction; convulsions, death
  - effective against most all types of insect pests, but is used particularly for aphids and caterpillars--soft bodied insects.

**EcoSMART™ plant oil-based pesticides**

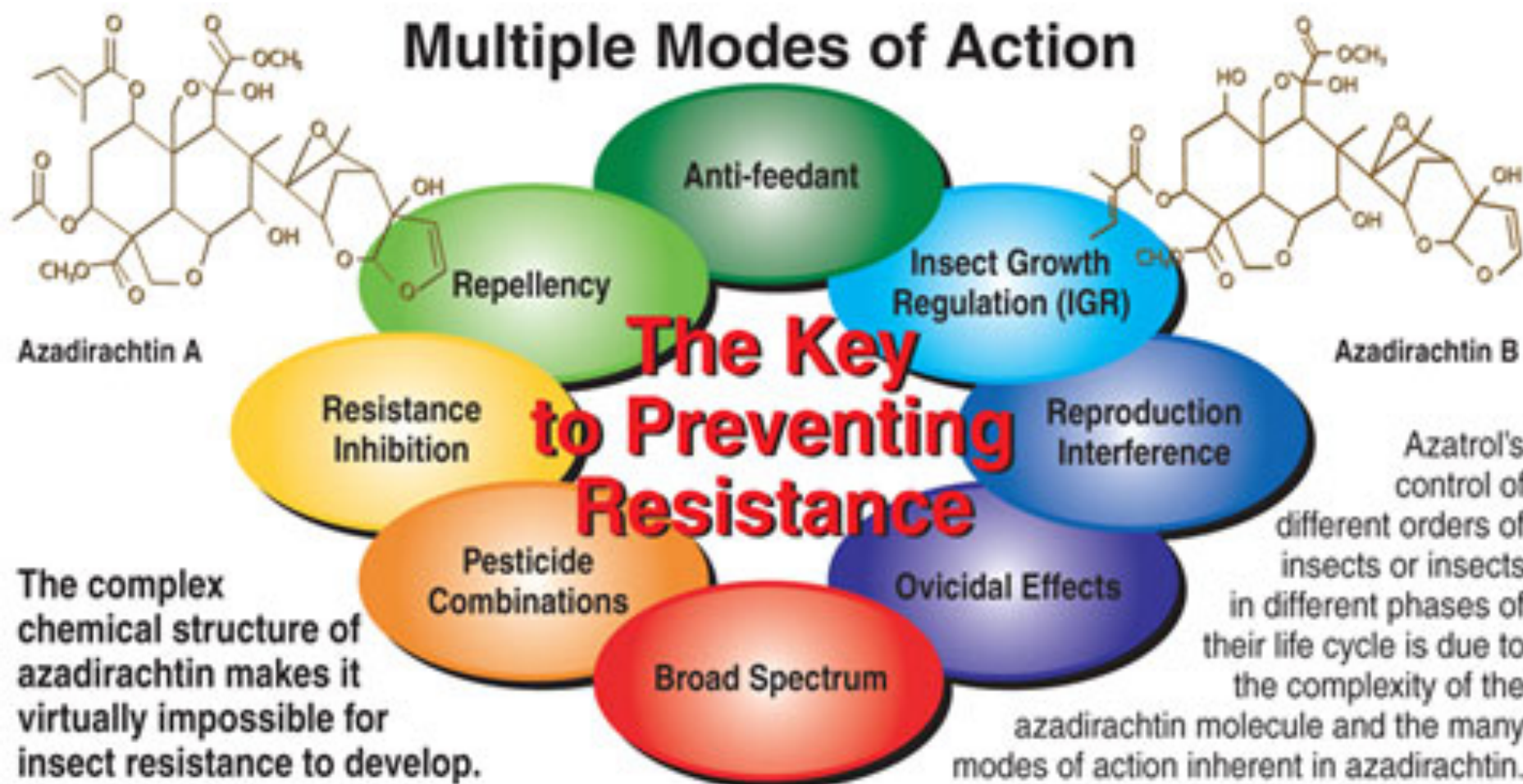


# Neem Oil/ Azadiractin



Aza Product	Application (light)	Application (heavy)	Price
<b>AzaMax 16 oz</b> 16 oz / 473 ml / .5 qt 1.2% Aza	.7 oz : 1 gal makes <b>23 gallons</b>	2 oz : 1 gal makes <b>8.5 gallons</b>	<b>\$74.95</b> Light - \$3.25/gal Heavy - \$8.81/gal
<b>Azatrol 1 qt</b> 32 oz / 946 ml / 1 qt 1.2% Aza	.7 oz : 1 gal makes <b>46 gallons</b>	2 oz : 1 gal makes <b>16.9 gallons</b>	<b>\$112.95</b> Light - \$2.45/gal Heavy - \$6.68/gal
<b>AzaPlus 250 ml</b> 8.4 oz / 250 ml / .26 qt 3% Aza	1 ml : 1 liter makes <b>64 gallons</b> (3x Azamax / 1.5x Azatrol)	2 ml : 1 liter makes <b>33 gallons</b> (4x Azamax / 2x Azatrol)	<b>\$119.95</b> Light - \$1.87/gal Heavy - \$3.63/gal <b>Best Value!!!</b>

## Multiple Modes of Action





# More pesticide safety tips



<http://www.gemplers.com/img/pesticide-storage-area-126066.jpg>



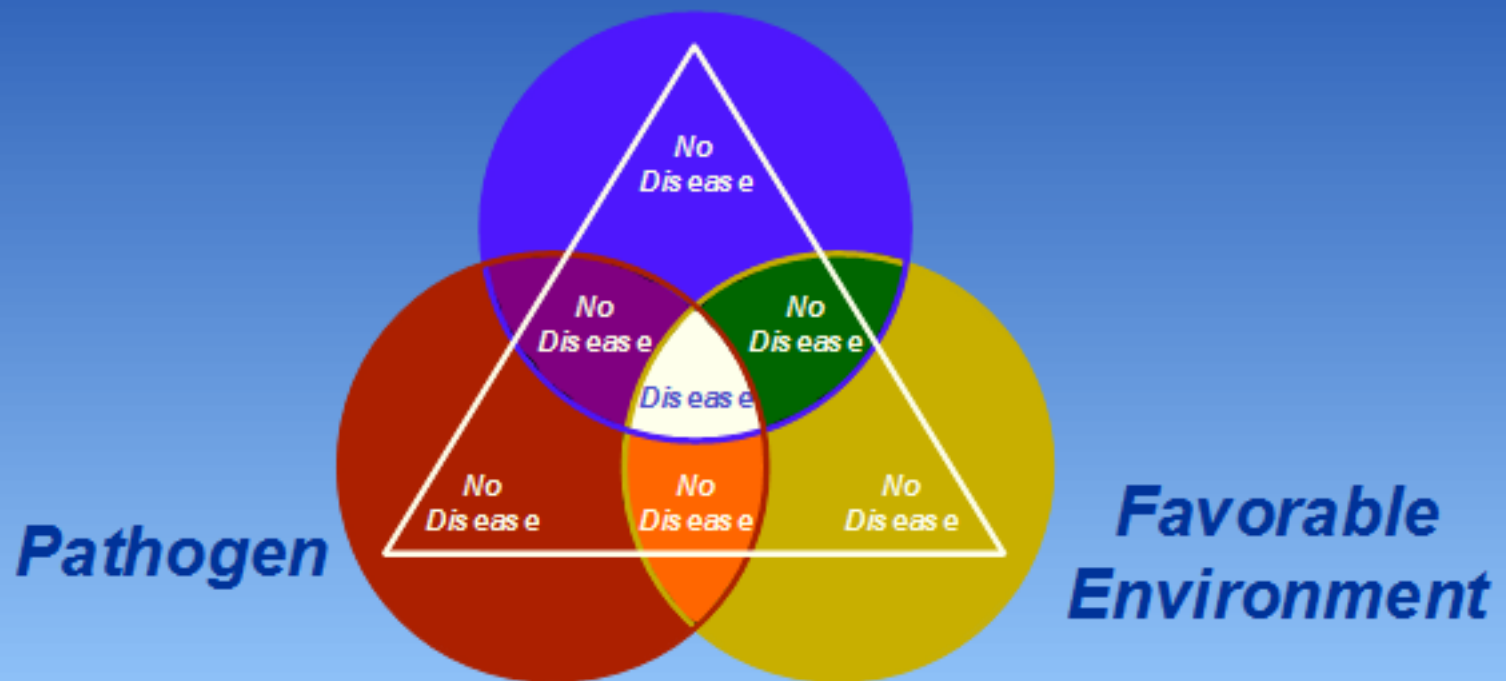
- Keep pets and people away from the area where you store, mix, and apply pesticides. Stay away from a treated area for as long as the label directs.
- Do not spray on a windy day or when air temperatures will be above 85°F before the spray solution dries.
- Clean equipment and mixing tools as soon as you finish spraying.
- Dispose of pesticides properly
  - After spraying, change your protective clothing and bathe. Wash the clothes you were wearing separately from your regular laundry.
- Keep records of where and when you sprayed, what pesticide you used, and how much you used. Give the treatment time to work, then evaluate and record your results.

# The Disease Triangle

2

## *Plant Diseases* *The Disease Triangle*

*Susceptible Host*



# Powdery Mildew - *Sphaerotheca pannosa* fungus



<http://www.extension.umn.edu/distribution/horticulture/DG1163.html>

- Susceptible: Rose family, Dogwoods, Honeysuckles, Sycamores, Willows, Sunflower
- Occurs during **warm, damp/humid weather**; spores overwinter in infected wood & fallen leaves
- Preventive cultural practices:
  - Provide good air circulation, appropriate sunlight conditions
  - Don't over-water; no overhead irrigation
  - Remove & dispose of infected leaves
  - Cut back & dispose of infected branches; dispose of fallen leaves
- Chemical controls: fungicides - copper, sulfur, horticultural oils & Neem Oil





<http://gardeningwebguide.com/GardeningBlog/category/garden-pests/>

# Rusts – large group of foliage fungi attacking many plant species

- Occur during warm, damp/humid weather; spores overwinter in infected wood & fallen leaves
- Preventive cultural practices:
  - Provide good air circulation, appropriate sunlight conditions
  - Don't over-water; no overhead irrigation
  - Remove & dispose of infected leaves
  - Cut back & dispose of infected branches; dispose of fallen leaves
- Chemical controls: fungicides – copper, sulfur, horticultural oils & Neem Oil



<http://www.omafr.gov.on.ca/english/crops/pub360/notes/rasporustf1.jpg>

READ SAFETY DIRECTIONS BEFORE OPENING.

**WARNING** S5  
KEEP OUT OF REACH OF CHILDREN

*Soluble Corrective Elements*

# Copper Sulphate

- BLUESTONE -

*Helps to correcting Copper deficiencies  
common in Acid Soils and apply  
directly to soil surrounding root system*

Cu



**500g Net**

**Manutec**

GARDEN CARE PRODUCTS

Dissolve 2 Spoonfuls  
(10g) to 1 litre of water  
and apply directly  
to soil surrounding  
root system

*Soluble Corrective Elements*  
**Copper  
Sulphate**

500g Net

**Manutec**

GARDEN CARE PRODUCTS

# Fungal Canker Diseases





# FireBlight





# Borers Attack Stressed Plants





# Borers





# Blights & Branch Die-back





# Blights & Branch Die-back





# Phytophthora



Joseph O'Brien, USDA Forest Service

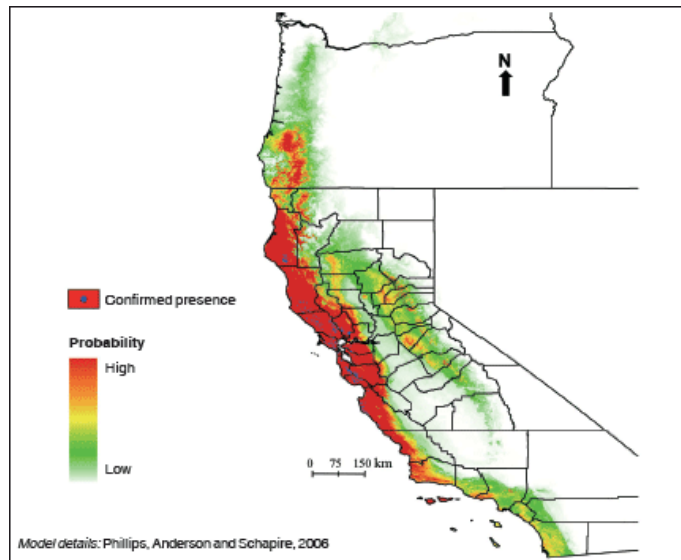
UGA5297081



# Sudden Oak Death Syndrome - *Phytophthora ramorum*



- Kills CA native oaks and other trees/shrubs in N. CA & OR (for now)
- Toyon (*Heteromeles arbutifolia*), Coffeeberry (*Rhamnus californica*), CA Buckeye and Honeysuckle (*Lonicera hispidula*) and others are susceptible. Disease symptoms have not been well characterized on these hosts at this time.
- Leaf lesions are characteristically round with a bulls-eye appearance of alternating light and dark rings





**Toyon** *Heteromeles arbutifolia*



**California buckeye** *Aesculus californica*



**California honeysuckle** *Lonicera hispidula*



**Pacific madrone** *Arbutus menziesii*



**Evergreen huckleberry** *Vaccinium ovatum*



**Bigleaf maple** *Acer macrophyllum*



**Wood rose** *Rosa gymnocarpa*

A number of other native broad-leaf species harbor *Phytophthora ramorum* in California and Oregon (See the complete list in Part 1.). Little is known about the role of these species in the life cycle and spread of the disease. The pathogen is difficult to culture from many of these species, and is difficult to diagnose because of the presence of other foliar diseases.



# Sycamore anthracnose - *Gnomonia leptostyla*



- The only serious disease of sycamores; will not kill the tree.
- Common in cool wet weather of spring.
- Monitoring:
  - First symptoms appear on young leaves as they unfold.
  - Older leaves turn brown, and dead areas occur along the leaf veins. Brown areas eventually include the whole leaf.
  - The ends of twigs may be killed back 8 to 10 inches.
  - Cankers may develop on the tree trunk and main branches
- Preventive cultural practices:
  - Proper tree spacing and pruning to promote good air circulation
  - Gather and destroy all fallen leaves and twigs.
  - Prune out all infected twigs and branches and destroy them. Remove the dead, cankered tissue down to healthy wood.
  - Dry winters weaken trees, increasing the effects of diseases. To reduce this problem, water trees once a month during dry winters.
- Chemical controls:
  - Chemical sprays normally are not necessary to control anthracnose



*That's all Folks*

