Pistachio Integrated Pest Management
And why it’s so important
An Overview for Australian Growers
WHAT IS A PEST?
WHAT IS A PEST?
Definition of a ‘Pest’

Fungus, insect, nematode, rodent, weed, or other form of terrestrial or aquatic life form that is injurious to human or farm animal health, or interferes with economic activities i.e profit in industries such as agriculture and logging.
Simple Definition of ‘Pest’

An organism in the wrong place at the wrong time.
Best Method of Control for Pests?

Prior to Integrated Pest Management – early to mid last century.

• Spray with ‘new’ chemicals
• If a little didn’t work, use more...
1939 The NEW organic chemical best friend is introduced....

dichlorodiphenyltrichloroethane
And it’s used everywhere, anytime, anyhow...
And it’s used everywhere, anytime, anyhow...
And it’s used everywhere, anytime, anyhow...
And it’s used everywhere, anytime, anyhow...
And it’s used everywhere, anytime, anyhow...
And it was used everywhere... Let’s sing....

“DDT is good for me-e-e-e!”
Actually.......No it isn’t

Problems with DDT: DDT is not metabolized very rapidly by animals; instead, it is deposited and stored in the fatty tissues → biomagnification
The Pesticide Treadmill

1. Spray, kill pest & natural controls. Pest comes back. Repeat until...
3. Induce secondary pest
4. Begin spraying for secondary pest until...
5. Resistance in secondary pest
6. Change chemicals. Repeat sequence.
Other problems...Resistance
Silent Spring
Rachel Carson
1962
Silent Spring Aftermath

- **1963** – President’s Science Advisory Committee issues report calling for reducing pesticides’ effects.
- **1963** – Senate calls for creation of Environmental Protection Commission
- **Early – mid ’60’s** – Increased sensitivity in analytical equipment enables detection of parts/billion. Including other chemicals.
- **1965** – First pesticide food tolerances
- **1969** - The term Integrated Pest Management – IPM - was used for the first time.
- **1970** - Public became increasingly negative toward chemical companies
- **1972** – DDT banned in the USA
Timeline of (Integrated) Pest Management

- 8000 BC - Beginning of agriculture
- 2500 BC - First records of insecticides (sulfur compounds)
- 300 AD - First use of biological controls (predatory ants)
- 1732 - Farmers grow crops in rows to facilitate weed removal
- 1890 - Introduction of lead arsenate for pest control
- 1896 - First selective herbicide (iron sulfate for broad-leaf weeds)
- 1901 - First biological control of a weed
- 1899 - Breeding program developed for cotton
- 1929 - First area-wide eradication of an insect pest
- 1942 - First successful plant breeding program for insect resistance
- 1950 - First application of systems analysis to control pests
- 1969 - Term Integrated Pest Management formalized
- 1972 - USA makes IPM National policy through Plant Protection Act
Pistachio Pest Threats for Australia

From the Threat Summary Table, Biosecurity Plan for The Nut Industries, V 3.0, January 2016

Invertebrates

- Pistachio Root Beetle: *Capnodis cariosa*
- Pistachio Twig Borer Beetle: *Chaetoptelius vestitus*
- Khapra Beetle: *Trogoderma granarium*
- Pistachio Bug: *Acrosternum heegeri*
- Pistachio Green Stink Bug: *Acrosternum millieri*
- Common Pistachio Psylla: *Agonosceana pistaciae*
- Pistachio Bug: *Apodiphus amygdali*
- Pistachio Bug: *Brachynema germari*
- Pistachio Bug: *Brachynema segetum*
- Mirid: *Campylomma lindbergi*
- Green Stink Bug: *Chinavia hilaris*
- Say’s Stink Bug: *Chlorochroa sayi*
- Uhler’s Stink Bug: *Chlorocroa uhleri*
- Gill’s Mealybug: *Ferrisia gilli*
- Glassy Winged Sharpshooter: *Homalodisca vitripennis*
- Leaf Footed Bug: *Leptoglossus clypealis*
- Western Conifer Seed Bug: *Leptoglossus occidentalis*
Pistachio Pest Threats for Australia

From the Threat Summary Table, Biosecurity Plan for The Nut Industries, V 3.0, January 2016

Invertebrates (cont.)

- Western Leaf Footed Bug: *Leptoglossus zonatus*
- Black and Red Bug: *Lygaeus equestris*
- Leaf Roller Pistachio Psyllid: *Megagonoscena viridis*
- California Buckeye Bug: *Neurocolpus longirostrus*
- False Cinch Bug: *Nysius raphanus*
- Pistachio Red Bug: *Spilostethus pandurus*
- Red Shouldered Stink Bug: *Thyanta pallidovirens*
- Pistachio Seed Chalcid: *Megastigmus pistaciae*
- Navel Orange Worm: *Amyeloidis transitella*
- Oblique Banded Leafroller: *Choristoneura rosaceana*
- Pistachio Twig Borer: *Kermania pistaciella*
- Gypsy Moth (Asian and European): *Lymantria dispar*

Pathogens and Nematodes

- Pistachio Bushy Top Syndrome: *Rhodococcus fascians*
- Gum Canker: *Cytospora terebinthi*
- Powdery Mildew: *Phyllactinia guttata*
- Texas Root Rot: *Phymatotrichopsis omnivora*
Pistachio Pest Threats for Australia

From the Threat Summary Table, Biosecurity Plan for The Nut Industries, V 3.0, January 2016

Pathogens and Nematodes (cont.)
- Asian Pistachio Rust
- Pistachio Rust
- Leaf Spot
- Septoria Leaf Spot
- Septoria Leaf Spot
- Verticillium Wilt
- Peter’s Scorch

Pathogens:
- Pileolaria pistaciae
- Pileolaria terebinthi
- Pseudocercospora pistacina
- Septoria pistaciae
- Septoria pistaciarum
- Verticillium dahliae
- Unknown at present

What about elsewhere in the world?
Pistachio Pests Currently in the USA
From: http://ipm.ucanr.edu/PMG/selectnewpest.pistachios.html

Invertebrates
- Navel Orangeworm
- Oblique Banded leafroller
- Citrus Flat Mite
- Plant Bugs
- Leaffooted Plant Bugs
- Stink Bugs
- Soft Scales
- Western Tussock Moth
- False Chinch Bug
- Pistachio Seed Chalcid

Amyelois transitella
Choristoneura rosaceana
Brevipalpus lewisi
Lygus hesperus, Phytocoris spp.
Leptoglossus clypealis
Thylantus pallidovirens
Coccus hesperidium, Saisietta, oleae
Orgyia vetusta
Nysius raphanus
Megastigmus pistaciae

Pathogens and Nematodes
- Blossom and Shoot Blight
- Panicle and Shoot Blight
- Alternaria Late Blight
- Sigmatomycosis
- Fruit Moulds

Botryotinia fuckeliana* <- What?
Botrosphaeria dothidea
Alernaria alternata & spp.
Nematospora coryli
Stemphyllium spp.

* Named after a German mycologist Carl Fuckel.
Pistachio Pests Currently in the USA
From: http://ipm.ucanr.edu/PMG/selectnewpest.pistachios.html

Pathogens and Nematodes (cont.)
• Powdery Mildew  \textit{Oidium spp}
• Verticillium Wilt  \textit{Verticillium dahlinae}
• Armillaria Root Rot  \textit{Armillaria mellea}
• Nematodes  \textit{Pratylenchus neglectus}

So what Pistachio pests are in Australia?
Pistachio Pests Currently in Australia

Invertebrates
- Carob Moth (?) \( \text{Apomyelois ceratoniae} \)
- Rutherglen Bug (?) \( \text{Nysius vinitor} \)
- Apple Dimpling Bug (?) \( \text{Campylomma liebknechtii} \)
- Carpophilus Beetle (?) \( \text{Carpophilus marginellus & spp} \)
- Light Brown Apple Moth (?) \( \text{Epiphyas postvittana} \)
- Thrips (?)

Pathogens
- Anthracnose (2011!) \( \text{Colletotrichum acutatum} \)
- Panicle and Shoot Blight (Bot) \( \text{Botrytis sphaeria spp.} \)
- Blossom & Shoot Blight \( \text{Botrytis cinerea} \)
- Alternaria Late Blight \( \text{Alternaria alternata} \)
- Pistachio Dieback \( \text{Xanthomonas translucens} \)

Mostly fungal pathogens, though insects may be disease vectors.
So what then is Integrated Pest Management (IPM) and how can it help us?
The Definition of IPM

**IPM** is a pest management philosophy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties. Each pest management technique must be environmentally sound and compatible with producer objectives.
What IPM is...

• Widely used to minimize loss to fruit, vegetables, field crops, stored products and forestry
• The goal is to limit damage and minimize economic losses in an environmentally acceptable manner
• It is recognized that no single approach can offer a universal solution, thus the need for Integrated Pest Management (IPM)
• Knowledge based and understanding the life history and mating habits of the pest is essential
• *It isn’t a magic bullet that will fix all problems*
Integrated Pest Management

Chemical Controls

Monitor Pests
- Insects
- Diseases
- Weeds

Biological Controls

Cultural Controls
“A pest management philosophy….. “

• Recognizes there is no “cure-all” in pest control.
  • Dependence on any one pest management method will have undesirable effects.

• Determines and corrects the cause of the pest problem.
  • Understanding Pest biology and ecology is essential.
  • Manipulate the environment to the crop’s advantage and to the detriment of the pest.

• Recognizes that eradication of a pest is seldom necessary or even desirable, and generally not possible.
  • Some damage is unavoidable and acceptable
IPM - Pest Management Strategies:

- **Prevention** – methods include planting disease free plants, resistant varieties, plant or harvest dates unfavorable for pest, removal of overwinter sites. Cultural Controls.

- **Suppression** – reduce existing populations to tolerable levels. Methods include biocontrol, mowing weeds or cultivating row crops, removal of trash – on and off tree, pesticide sprays

- **Eradication** – aimed at totally eliminating the pest from an area – usually for newly introduced exotic pest species. Often unsuccessful.
IPM Control Methods

• **Legal control:** following state and federal guidelines that are designed to prevent the spread of pests

• **Cultural control:** using crop rotation, cultivation, sanitation, habitat modification, or removal of sources of pest infestation

• **Physical control:** using barriers, traps, trap crops; planting, fertilization, tillage, or harvest times
IPM Control Methods

- **Genetic control**: using plant varieties that are resistant to pest injury

- **Biological/Natural control**: conservation or introduction of predators, parasites, and diseases that suppress or attack pests

- **Chemical control**: select and use the least toxic, environmentally suitable pesticides in the lowest effective amounts to control pests
IPM
What is “normal”? - Is it really a pest problem?
Stylar end lesion - Chocolate nuts

- 10-15% damage
- Only on rootstocks *P. terribinthus* and *P. atlantica* but not on Pioneer Gold
- **Ca, Mg and K** ← It’s a nutrient/rootstock problem!
IPM

What is the problem? Proper Pest identification is critical.
IPM

Know your ‘good bugs’ from your bad bugs
Beneficial insects found in Pistachios

Coccinellidae

Chrysopidae

Schellenberg's soldier bug

Parasitic Hymenoptera
IPM

How and what does the pest attack?

• Only the plant of interest affected?
• Parts of plant affected?
• Patterns in field?
• Know the pests lifecycle (Anthracnose below)
IPM

How many pests are there?

- Is it too early or too late to control?
- Management must be at the correct time to maximize effectiveness.
- Monitor in a structured manner
- Record all pests levels and beneficials
IPM Monitoring

• Use IPM checklists
• During problem times, such as Spring, some areas may have to be visited weekly – or more often – looking for pest infestations
• Results should be compared to previous findings to determine trends. If you don’t have a baseline how do you know what has changed?
• Records should have dates, temperatures, specific location, host plant or area of infestation, pest(s), and natural enemies present, ideally there should be a description of the sampling procedure with the resulting counts.
• Records should also document any control measures undertaken.
IPM

Example of a pest/beneficial monitoring sheet

<table>
<thead>
<tr>
<th>Date</th>
<th>Field #</th>
<th>Time</th>
<th>Crop</th>
<th>Growth Stage</th>
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</table>

**Weather/field observations:**

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<th>Plant #</th>
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<td>Pest 2</td>
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Notes:
IPM
Methods of Pest Monitoring
IPM

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Methods of Pest Monitoring
Look at more than one tree

Aim to assess a minimum of 50-100 bunches.
Monitoring patterns

• Sampling patterns should be modified to account for variation in an orchard.

• Random problem (e.g., some insects)
  – Fewer stops
  – More trees/bunches assessed at each stop

• Aggregated (e.g., soilborne disease)
  – More stops (some in and out of problem areas)
  – Fewer plants assessed at each stop
Kyalite pistachio orchard insects
2016-17 season

- Carpophilus marginellus
- Rutherglen Bug
- Weevils
- Thrips
- Light brown apple moth
- Carob moth
- Mealybug

IPM
Figure 3a: Record of moths trapped each week demonstrating how population varies over time
IPM

Determine an action threshold
Through specific research programs

• How many pests are too many?
• What is the general equilibrium position?
• Economic, health, and aesthetic threshold
• Economic Injury level?
• Economic threshold?
Economic Injury level vs Economic Threshold

- above EIL, benefit > cost
- below EIL, cost > benefit
- pest population without control
- EIL
- ET
- GEP
- control
Three Important Components

• **Economic injury level**
  – Lowest population density that will cause economic damage

• **Economic threshold**
  – Population size large enough to trigger an action to prevent an increasing pest population from reaching the economic injury level

• **General equilibrium position**
  – Average density of a population over time
BUDMON/ONFIT Testing - SARDI

- BUDMON testing in winter and ONFIT testing in summer allow growers to assess the fungal load within their trees. If the fungal load is low, the fungicide program can be scaled back except in adverse weather. If the fungal load is high, a heavy fungicide program should be planned.

- You need to use BUDMON testing each winter. If you do not, you will have little idea of the fungal problems confronting you in the coming season.

- If you are considering BUDMON testing for Anthracnose - *Colletotrichum spp.* and/or *Botryosphaeria spp.* presence, PLEASE contact Barbara Hall or Sue Pederick at SARDI before bud sampling or sending samples.
IPM

Choose appropriate management tactics
• For many pests, there are several management options to consider.

Review your work:
• Was the management effective?
• Did actions do what you wanted?
• Was the method itself satisfactory?
• Were there any unintended side effects?
• What will be done in the future for this pest situation?
IPM
Things to consider when choosing an insecticide

• Efficacy against the target pest.
• Susceptibility of the crop to pest damage
• Impact on natural enemies
• Insecticide Resistance Management Strategies
• Ability to control multiple target species
• Withholding periods and insecticide residues
• Toxicity to the environment and humans
• Cost
IPM – Example - Anthracnose
IPM – Example - Anthracnose

BUDMON - Colletotrichum

Percent buds infected

2009 2010 2011 2012 2013 2014
IPM – Example - Anthracnose

- *Colletotrichum spp.* spores, frequent rain events and mild temperatures, trigger epidemics on many hosts. **Rain will splash spores from active lesions to new sites of infection,** thereby increasing the severity of the disease in an orchard.
- The 2010/11 growing season lacked the usual periods of high-extreme heat (days with maximum above 40°C). The pathogen grows rapidly in high humidity at 20°C-25°C, and at a negligible rate, above 35°C and below 5°C.
- By the end of the 2010/11 season, leaves, rachises and nuts on both scion varieties, were severely infected.
- **From early spring,** close inspections of all plant parts, is needed. Infection of immature fruit occurs but may not result in extensive symptoms until the fruit starts maturing. As harvest approaches, lesions on infected clusters will rapidly expand and coalesce, hulls blacken, and the pink-orange spores of the fungus will become visible *en masse.*
IPM – Example - Anthracnose

• **Sanitation:** This is **most** important, albeit expensive
  • Re-shake to remove all infected nuts and rachises
  • Remove, mulch and/or incorporate under tree debris
• Don’t prune during rain
• Understand and act on the underlying threat for the next season – spray if needed.
• **Monitor** the fungi in dormant buds (BUDMON)
## IPM – Example, Disease Management

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
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<td><strong>ORCHARD FLOOR</strong></td>
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<td><strong>Sanitation</strong> - clear under canopy; remove debris, weeds, vegetation, habitats that harbour pests/disease</td>
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<td><strong>Water management</strong> - review and refine drainage and irrigation systems</td>
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<td><strong>Plant/replant</strong> - inspect; only plant healthy stock; record sources of scion and rootstock material; map new plantings</td>
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<tr>
<td><strong>Action</strong> - remove stuck rachises, mummified nuts, twigs with <em>Botryosphaeria</em> (“Bot”), pycnidia or cankers,</td>
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<tr>
<td><strong>Monitor</strong> - bud infection by “Bot” and <em>Colletotrichum</em> (Anthracnose), submit BUDMON samples</td>
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<td><strong>Prune</strong> - open canopies to improve airflow; don’t prune during rain</td>
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<tr>
<td><strong>Monitor</strong> - populations of scale especially on 1 year old shoots. Moderate populations can be controlled with dormant oil</td>
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From PGAI Pistachio Disease Management Information Sheet.
Figure 3.1 Integrated Pest Management Decision Flow Chart (Peacock and Smart, 1995)

- Experience and database information
- Establish pest thresholds
- Establish monitoring programs
- Establish potential pest problems
- Establish curative techniques

- Conditions favourable for pest
  - No curative action needed

- Implement preventative strategies
- Monitor for pest presence or symptoms of pests
- Pests are present or symptoms of pests are found
  - Continue pest monitoring program
  - Yes

- Identify pest and level of damage
- Does damage and do pest levels exceed thresholds?
  - No
  - Yes

- Implement curative treatment
  - Consider all curative techniques
  - Use risk assessment techniques to select pesticides

- Determine effectiveness of treatment
- Determine effectiveness of management strategies
IPM Model of Continual Improvement

**STEP 1 - KNOWLEDGE**
- Key pests
- Pest lifecycles
- Natural enemies
- Growing area

**STEP 2 - PREVENTION**
- Site selection
- Variety
- Time of planting & rotations
- Water & nutrition management
- Farm hygiene
- Pest host management

**STEP 3 - OBSERVATION**
- Crop monitoring
- Pest prediction models
- Pheromone traps
- Yellow sticky traps

**STEP 4 - INTERVENTION**
- Mechanical controls
- Biological controls
- Chemical controls

**STEP 5 - EVALUATION & PLANNING**
- Review monitoring records,
  Talking, listening, reading,
  thinking
- Consult & adapt

IPM model of continual improvement
Ultimate goal of IPM: Is to increase the responsible pesticide/fungicide use.

- Don’t apply when it isn’t needed
- Apply effectively when it is needed
- Weigh and apply alternative treatments wisely
- Know what happened afterward
IPM

- An IPM program must be well researched prior to implementation
- The researcher must have extensive knowledge of the pest as well as the plants being protected
- Successful IPM programs saves billions of dollars (globally) each year in crops
- Natural pheromones play a vital role in most programs
- IPMs vary from the simple to the complex
- In one way or another, we have each benefited from the use of IPM programs.
IPM

Much Information is out there – use trusted sources

• There still is much to learn about pest complexes in Pistachio crops – knowledge gaps.
• What is known is available through the PGAI website.
• All PGAI pest/disease fact sheets
• PGAI Pistachio Pest and Disease Manual
• PGAI Pistachio Chemical and Disease management factsheets
Thank You
CALVIN AND HOBBES

THE DAYS ARE GETTING COLDER.
YES.
BUGS ARE DYING BY THE TRUCKLOAD!
HA HA HA!
GOOD RIDANCE TO 'EM ALL.

I LIKE FALL.

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INSANITY STREAK

DORIS POSTED A PHOTO OF HER DECAPITATED HUSBAND ON FACEBUG!

SHE UPLOADED THAT ON INSECTAGRAM TOO!