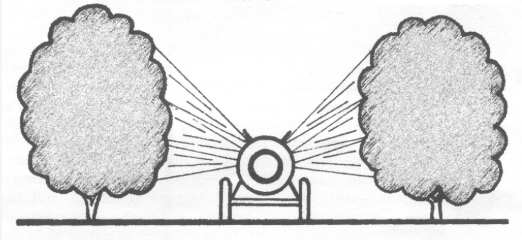
Orchard spray rates:

How to Decide the Amount of Water & Insecticide to Use on Fruit Trees



Celeste Welty
Extension Entomologist
February 2016

THE OHIO STATE UNIVERSITY

Pesticide Rates

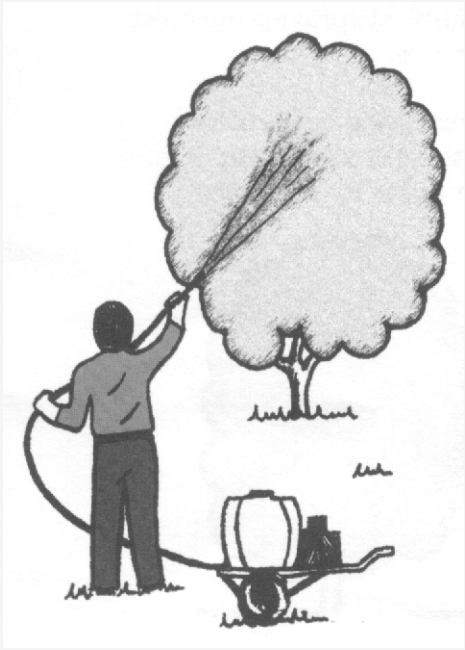
- **Amount per 100 gallons:** the dilute rate
- **Amount per acre:** the concentrate rate

Pesticide Rates

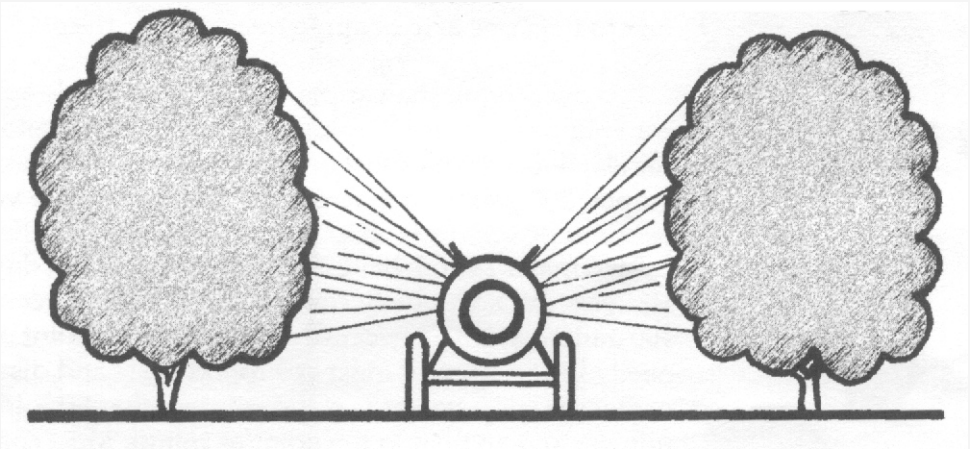
- **Amount per 100 gallons:** the dilute rate
- **Amount per acre:** the concentrate rate
- **Customized applications by tree row volume**

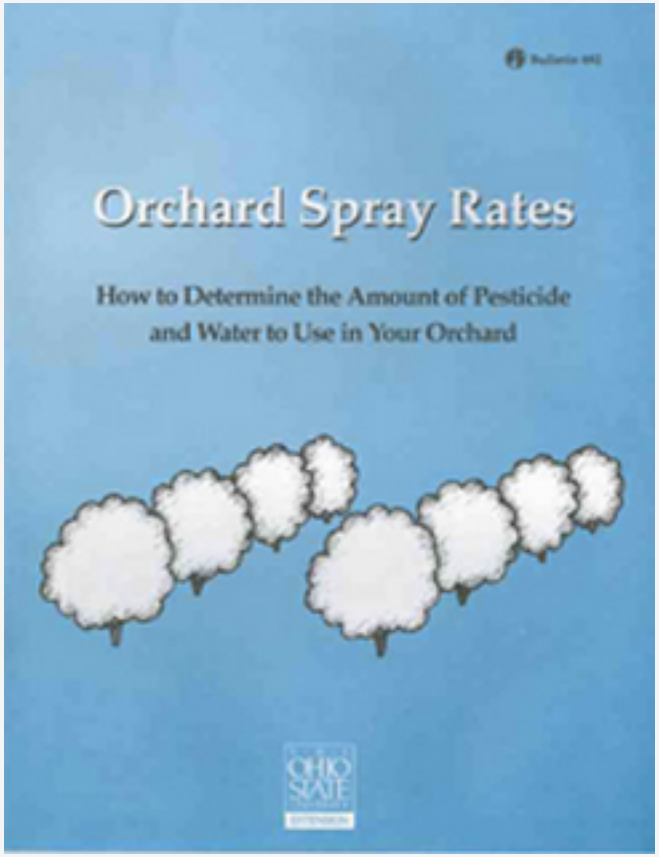
Types of Application

- **Dilute = point of runoff**



- **Concentrate (low volume)**





OSU Extension Bulletin 892
21 pages, published 2001

Example

DIAZINON AG600 WBC
Insecticide

APPLES (21)	Woolly Apple Aphid	12 ¾ fl. oz. in 100 gals. of water
	San Jose Scale	12 ¾ fl. oz. in 100 gals. of water

Standard Conversion from Dilute Rate to Per Acre Rate

Based on assumption that it takes 400 gal/A of water to spray apple trees to point of runoff

Rate of pesticide per acre = (Rate per 100 gal water) x (400 gal/acre)

Example, Diazinon AG600: (12.75 fl oz/ 100 gal) x (400 gal/A) = 51 fl oz/A

Dilute Volume for Fruit Crops

Crop	Dilute volume
apples	400 gal/A
peaches	300 gal/A
berries	200 gal/A

Example

RESTRICTED USE PESTICIDE

TOXIC TO FISH, MAMMALS, AND AQUATIC ORGANISMS

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

GROUP 6 INSECTICIDE

Agri-Mek® SC

Miticide/Insecticide

syngenta

Active Ingredient:

Abamectin[1] 8.0%*

Apples

Pest	For Dilute Sprays[1] fl oz/ 100 gal	For Concentrate Sprays[2] fl oz/A
European red mite McDaniel spider mite Tentiform leafminer Twospotted spider mite White apple leafhopper	0.5-1.0	2.25-4.25

[1]The rate of Agri-Mek SC per 100 gallons is based on a volume of 400 gal/A dilute spray.

[2]To determine the amount of product per acre for concentrate sprays, first determine the amount that would be required in a full cover dilute spray. Use the same amount of product/A in concentrate sprays as would be required for the dilute sprays to the same orchard/grove. This can result in use of less than 2.25 fl oz/A on small trees.

Orchards & Spraying: Historical Perspective

	Old days	Now
Tree size	Big	Small
Tree spacing	Wide	Narrow
Sprayer	Handgun	Airblast
Volume to runoff	400 gal/A	100-250 gal/A

Customized Application

- **Based on assumption that small apple trees take less than 400 gal/A to reach the point of runoff**

Customized Application

- 1st step: determine what volume per acre to runoff in YOUR trees
- Must be done even if you never actually make a dilute application
- This is basis of calculating how to do a customized low-volume concentrate spray

Dilute Spraying

- **How much water?**
  - **Standard (400 gal/A)**
  - **Customized**
- How much pesticide?

How to know dilute volume for a specific orchard

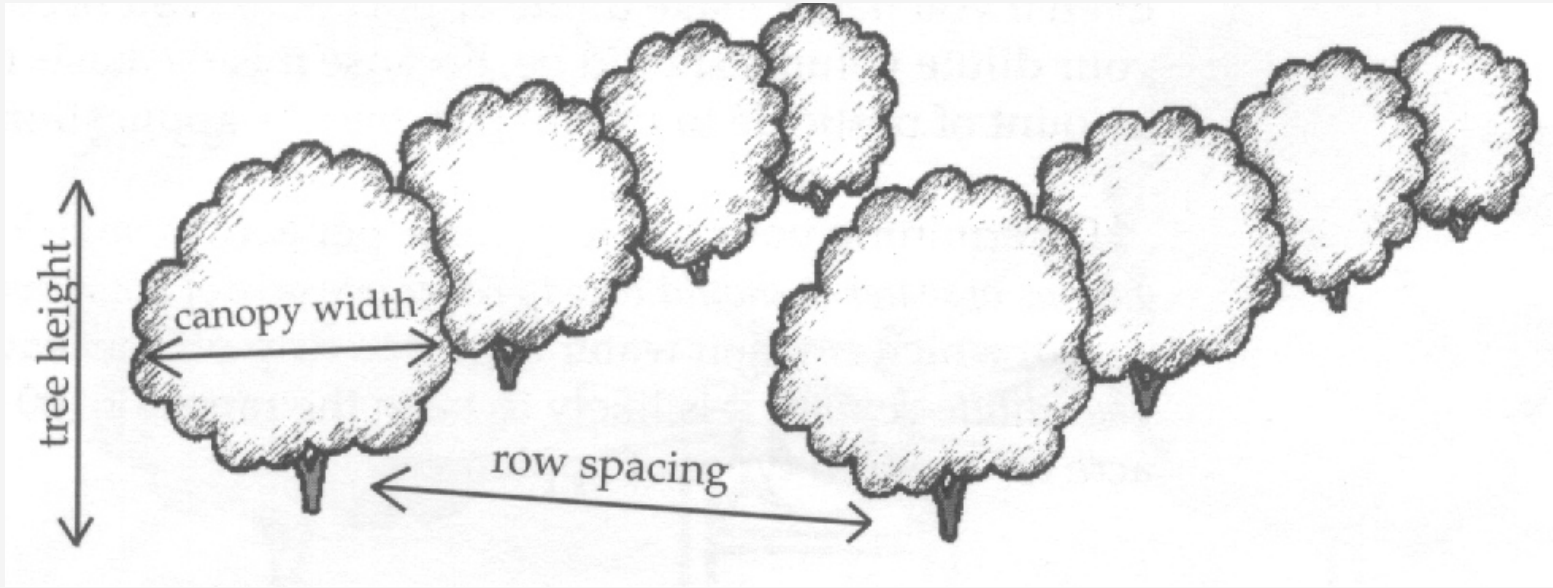
1) Experiment with sprayer
2) Use chart of common spacings
3) Use equation

Dilute volume chart

(p. 19 of bulletin)

Row spacing	Canopy width	Tree height	Minimum Dilute Gal/Acre
30’	20’	20’	407
20’	12’	12’	220
16’	8’	8’	122

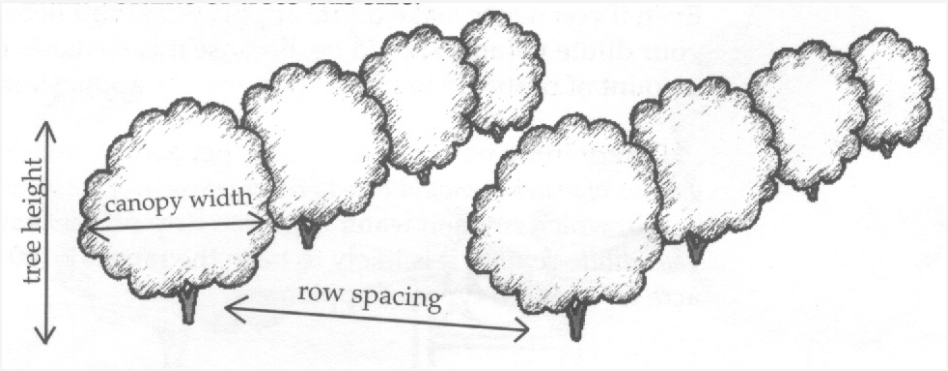
Equations



Step 1: get measurements

- Canopy width [ft]
- Tree height [ft]
- Row spacing [ft]

Equations



Step 2:

Canopy Width [ft] **x** **tree height** [ft] **x** **43,560 sq.ft./A** / **row spacing** [ft]

= tree row volume [cu.ft./A]

Step 3:

TRV x 0.7 gal/1000 cu ft = minimum dilute volume [gal/A]

Equations, example

- **Row spacing** 20 ft
- **Canopy width** 10 ft
- **Height** 12 ft
- **TRV = 10’ x 12’ x (43,560/20’)**
  = 261,360 cu. ft.
- **TRV x (0.7 gal/1000 cu.ft.) =** 183 gal/A

Dilute Spraying

- How much water?
- **How much pesticide?**
  - **(Dilute rate) x (dilute volume)**

Customized Dilute Spraying, example

- **How much pesticide?**

  (Dilute rate) x (YOUR dilute volume)

- **How much Diazinon AG600?**

  - (12.75 fl oz/100 gal) x (183 gal/A)
    = 23.3 fl oz/A

Concentrate Spraying

- Also called ‘low volume spraying’
- Airblast sprayer
- Typically 40-80 gallons per acre
- As amount of water per acre decreases, but the amount of pesticide stays the same, the spray mix becomes more concentrated than in a dilute spray

Concentrate Spraying

- **Amount of water to use?**
  - Depends on sprayer
  - Whatever volume needed to give adequate coverage
  - Typically 40-80 gallons per acre

Concentrate Spraying

- **What is the concentration?**

  = (amount of water per acre in your sprayer for dilute application) / (amount of water in your sprayer for concentrate application)

Concentrate Spraying

- **What is the concentration?**

  = (amount of water per acre in your sprayer for dilute application) / (amount of water in your sprayer for concentrate application)

- **Example:**
  - Your dilute volume = 180 gal/A
  - Your concentrate volume = 60 gal/A
  - Your concentration = 180 / 60 = **3x**

Concentrate Spraying

- **Amount of pesticide to use?**

What rate does label state?

- **3 typical answers:**
  - Amount per acre only
  - Amount per 100 gal only
  - Both
- **If only the amount per acre is given, then use this rate**
- **Trend??**

Concentrate Spraying

- **Amount of pesticide to use?**
- **4 possibilities:**
  - Label rate per acre
  - Standard conversion
  - Standard conversion less 20%
  - Customized by tree row volume

Standard Conversion from Dilute Rate to Full Per Acre Rate

Based on assumption that it takes 400 gal/A to spray apple trees to point of runoff

Full Rate of pesticide per acre = (Rate per 100 gal water) x (400 gal/acre)

Example, Diazinon AG600: (12.75 fl oz/ 100 gal) x (400 gal/A) = 51 fl oz/A

Standard Conversion Less 20%

- **Control with airblast often good with less than the full rate**
- **Common in 1970s & 1980s**
- **Example:**
  - Diazinon full rate = 51 fl oz/A
  - Diazinon full less 20% = 40.8 fl oz/A
- **Risky unless known by experience**

Tree Row Volume

your customized amount of pesticide per acre =

The dilute rate [amount of pesticide per 100 gallons]

x

your dilute volume

Tree Row Volume, example

- Captan 50WP
- Dilute rate: 1.5 lb/100 gal
- Your dilute volume: 183 gal/A
- your customized amount of pesticide per acre =

  (1.5 lb/100 gal) x (183 gal/A)

  = 2.74 lb/A

Tree Row Volume, alternate method

- Use percentage of standard
- Determine your dilute volume
- % of standard =
  (your dilute volume) / 400 gal/A
- Then multiply this by the full rate of pesticide per acre

Chart on page 19 of bulletin

Appendix 1: Tree row volume chart.

Distance between rows (feet)	Tree canopy width (feet)	Tree height (feet)	Tree row volume per acre (cubic feet, rounded to nearest 1,000)	Your dilute volume (gallons per acre)		Your dilute volume as a **percentage of standard** dilute volume			
						pome fruit (base 400 g.p.a.)		stone fruit (base 300 g.p.a.)	
				Mini-mum[1]	Maxi-mum[2]	Mini-mum[1]	Maxi-mum[2]	Mini-mum[1]	Maxi-mum[2]
40	22	22	527,000	369	527	92%	132%	123%	176%
30	20	15	436,000	305	436	76%	109%	102%	145%
26	16	12	322,000	225	322	56%	80%	75%	107%
24	14	12	305,000	213	305	53%	76%	71%	102%

Tree Row Volume, alternate method

Example:

- your dilute volume = 183 gal/A
- Your % of standard = 183 / 400
  = 0.46 = 46%
- Captan 50WP, dilute rate = 1.5 lb/100 gal
- Captan full rate =
  (1.5 lb/100 gal) x (400 gal/A) = 6 lb/A
- Your rate = 0.46 x 6 lb/A = 2.76 lb/A

3 Final Examples, #1:

- **Agri-Mek SC, 0.75 fl oz/100 gal**
- **How much for a dilute application to big old trees that require 400 gal/A to runoff?**
- **(0.75 oz/100 gal) x (400 gal/A) = 3 fl oz/A of Agri-Mek SC**

3 Final Examples, #2:

- Agri-Mek SC, 0.75 fl oz/100 gal
- How much for a dilute application to semi-dwarf trees that require 180 gal/A to runoff?
- (0.75 fl oz/100 gal) x (180 gal/A) =
  1.35 fl oz/A of Agri-Mek
- Note, this is less than the 3 fl oz/A of Agri-Mek needed for big trees in example #1

3 Final Examples, #3:

- Agri-Mek SC, 0.75 fl oz/100 gal
- How much for a concentrate spray to semi-dwarf trees that require 180 gal/A to runoff, if sprayer applies 60 gal/A?
- (0.75 fl oz/100 gal) x (180 gal/A)
  = 1.35 fl oz/A of Agri-Mek
- Note, compared to #2, this is same amount of Agri-Mek but in different amount of water
- What is the concentration? 180 / 60 = 3x

Orchard Spraying

Spray mix = water + pesticide

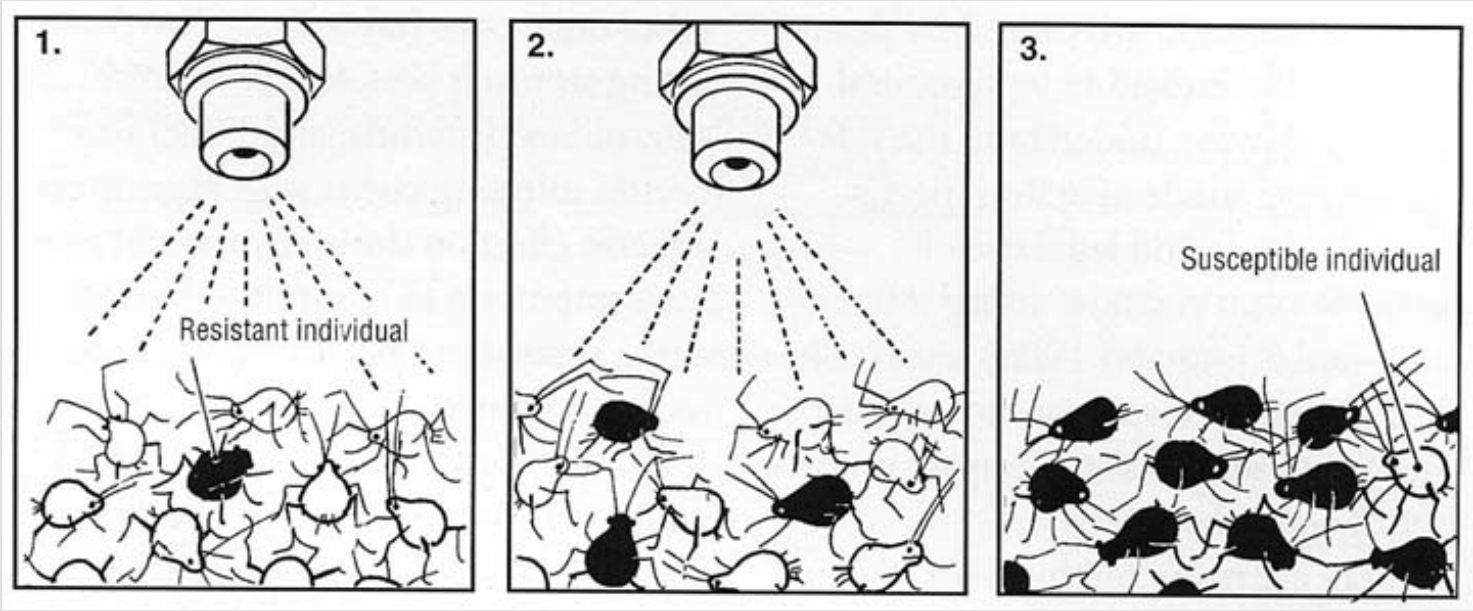
Any risks to under-dosing?

- **Pesticide resistance**

Insecticide Resistance

- The ability of an insect to survive exposure to a rate of insecticide that other individuals in the population cannot survive

Insecticide Resistance



- An inherited trait
- Begins with few rare individuals
- Develops after repeated selection pressure

Insecticide Resistance

- **Some species known for it:**
  - European red mite 
  - Pear psylla 
  - Colorado potato beetle 
  - Diamondback moth 

Tactics for management of insecticide resistance

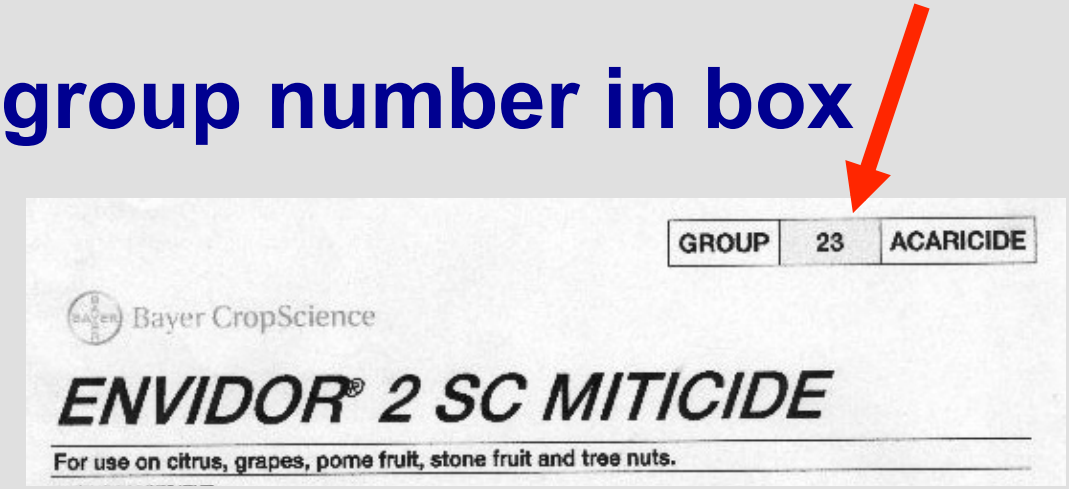
1. Use higher rate
2. Add piperonyl butoxide (PBO), a synergist
3. Mix insecticides
4. Use alternate methods: biological, cultural, mechanical methods
5. ** Rotate insecticide classes every pest generation **

Why rotate chemicals?

- Similar mode of action within chemical groups
- Mode of action = the biochemical effect of the chemical in the insect
- Cross-resistance = resistance to related chemicals after initial resistance to one chemical

Mode of action groups

- Currently 28 groups
- Organized in list at IRAC website
  - IRAC = insecticide resistance action committee
- New labels have group number in box at top of label



GROUP	23	ACARICIDE

Bayer CropScience

ENVIDOR® 2 SC MITICIDE

For use on citrus, grapes, pome fruit, stone fruit and tree nuts.

ACTIVE INGREDIENT:

Spirodiclofen: 3-(2,4-dichlorophenyl)-2-oxo-1-oxaspiro[4.5]dec-3-en-4-yl 2,2-dimethylbutanoate 22.3%

INERT INGREDIENTS: 77.7%

100.0%

ENVIDOR contains 2 pounds of Spirodiclofen per US gallon, or 240 grams per liter.

EPA Reg. No. 264-831 **EPA Est. No. 3125-MO-1**

STOP - Read the label before use

...DREN

GROUP	23	INSECTICIDE

OBERON 2 SC® Insecticide/Miticide

ACTIVE INGREDIENT:

Spiromesifen: 2-oxo-3-(2,4,6-trimethylphenyl)-1-oxaspiro[4.4]non-3-en-4-yl 3,3-dimethylbutanoate 23.1%

INERT INGREDIENTS: *76.9%*

OBERON 2 SC® contains 2 pounds of spiromesifen per US gallon (240 grams per liter). **TOTAL:** 100.0%

EPA Reg. No. 264-719 **EPA Est. No. 264-DEU-005**

STOP – Read the label before use.

KEEP OUT OF REACH OF CHILDREN

CAUTION

Insecticide Groups: older products

Group	*Chemical*	*Examples*
1A	carbamates	Sevin, Lannate, Furadan, Larvin
1B	organo-phosphates	Guthion, Lorsban, Diazinon, Orthene
2	organo-chlorines	Thiodan, Lindane
3	pyrethroids	Asana, Pounce, Baythroid, Mustang, Warrior

RESTRICTED USE PESTICIDE

DUE TO TOXICITY TO FISH AND AQUATIC ORGANISMS

FOR RETAIL SALE TO AND USE ONLY BY CERTIFIED APPLICATORS, OR PERSONS UNDER THEIR DIRECT SUPERVISION, AND ONLY FOR THOSE USES COVERED BY THE CERTIFIED APPLICATOR'S CERTIFICATION.

Warrior II with Zeon Technology®

Insecticide

Active Ingredient:	
Lambda-cyhalothrin[1,2]	22.8%
Other Ingredients:	77.2%
Total:	100.0%

Warrior II with Zeon Technology contains 2.08 lbs. of active ingredient per gal. and is a capsule suspension.

Insecticide Groups: newer products

Group	*Chemical*	*Examples*
4A	neonicotinoids	Assail, Calypso, Actara, Provado, Admire, Belay, Venom
5	spinosyns	SpinTor, Delegate, Entrust
6	avermectins & milbemycins	Agri-Mek, Proclaim
11	toxins by *Bacillus thuringiensis*	DiPel, XenTari

GROUP 4A INSECTICIDE

ASSAIL® 30SG

INSECTICIDE

For Agricultural Use Only

ACTIVE INGREDIENT:	**By Wt.**
Acetamiprid, (E)- N^1 -[(6-chloro-3-pyridyl)methyl]-N^2-cyano-N^1-methyl acetamidine	30.0%
OTHER INGREDIENTS:	70.0%
TOTAL:	100.0%

Insecticide Groups: IGRs

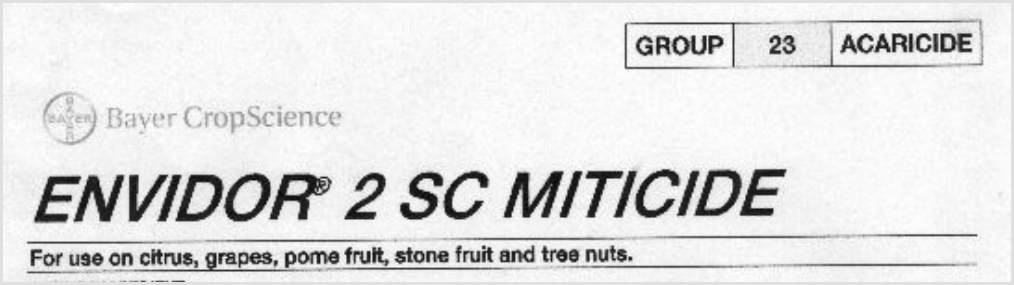
Group	*Chemical*	*Examples*
7	Juvenile hormone mimics	Esteem
15	Chitin inhibitors, Lepidopteran	Dimilin, Rimon
16	Chitin inhibitors, Homopteran	Courier, Centaur
17	Molting disruptor, Dipteran	Trigard
18	Molting disruptor	Confirm, Intrepid

Insecticide Groups

Group	*Chemical*	*Examples*
22	indoxacarb	Avaunt
28	diamides	Altacor, Belt, Coragen, Exirel

Mode of action groups

- Currently 28 groups
- Organized in list at IRAC website
  - IRAC = insecticide resistance action committee
- New labels have group number in box at top of label



- Rule: rotate to insecticide from a different group

Example:
European red mite on apple

- Many miticides now available
- Prone to developing resistance
- Key to resistance management is rotation among miticides with unrelated mode of action

Example: European red mite on apple

Group	*Product*	
1A	Carzol, Vydate	
6	Agri-Mek	
10A	Apollo, Savey	}related
10B	Zeal	
12	Vendex	
20	Kanemite	
21	Nexter (Pyramite), Portal	}related
23	Envidor	
25	Acramite	

Rotation of miticides for European red mite

- **Early-summer miticides:**
  - Year 1: Savey (10A) **OR** Apollo (10A) **OR** Zeal (10B)
  - Year 2: Agri-Mek (6)
- **Mid-summer miticides**
  - Year 1: Envidor (23)
  - Year 2: Nexter (21) **OR** Portal (21)
  - Year 3: Kanemite (20)
  - Year 4: Acramite (25)

Example: Wormy Apples

- Some control failures, 2002+
- Problems worst where some cover sprays skipped
- Main species: codling moth

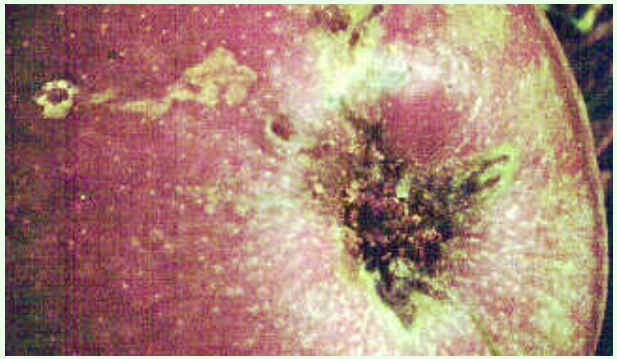
Codling moth: why problems?

- Resistance to organophosphates???
- Good overwintering survival
- Prolonged moth emergence
- Overlapping generations
- Partial 3rd generation
- Other species mixed in?

Wormy Apples

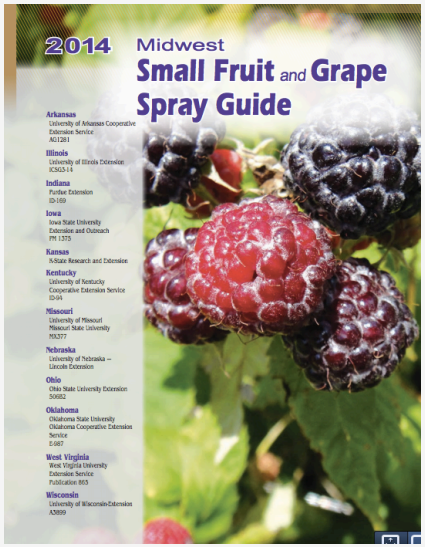
- **Main species:**
  - Codling moth
- **Other species:**
  - Oriental fruit moth (3-4 generations)
  - Lesser appleworm (same # generations)
  - European corn borer
  - Dock sawfly

Managing Oriental fruit moth in apples



- Better timing
- More water
  - 50 gpa minimum
  - 100 gpa in problem blocks & late
- Higher rates of O.P.s
  - Imidan 3-4 lb/A
- Rotate insecticides

News on spray guides



- **2015 & earlier:**
  - Midwest Small Fruit & Grape Spray Guide, 88 pp (~$10)
  - Midwest Tree Fruit Spray Guide, 72 pp (~$10)
  - buy from OSU
- **2016:**
  - Midwest Fruit Pest Management Guide, 168 pp (~$15)
  - buy directly from Purdue University

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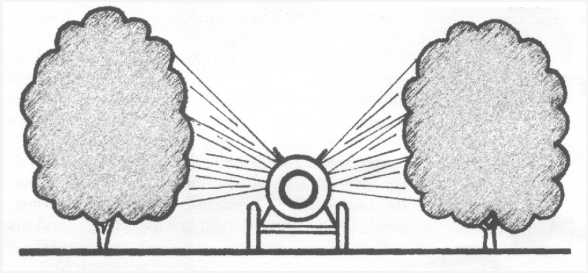

Info on fruit & veg. pests
u.osu.edu/pestmanagement/

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