

Insecticides: New Classes and Active Ingredients

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May 2005

Scope & Sources of Information

- **New insecticide classes and active ingredients introduced since about 1995**
- **Agricultural and commercial product lines (homeowner-type product lines not included)**
- **Sources for product information:**
Kelly Registrations Database (Internet)
Utah Pesticide Information System (local)
- **Crops and pests listed for products:**
specific types generalized here for brevity

Insecticide Resistance Action Committee (IRAC) Mode of Action Classification

- **Insecticides assigned to groups according to mode of action; groups are used here**
- **Different modes of action can be used to manage resistance in insect populations**
- **26 different modes of action included**
- **Classification does not include all insecticide active ingredients or all classes of new insecticides**

Groups for “Old” Classes & Active Ingredients (pre-1995)

- **Classes:** carbamates (1A), organophosphates (1B), organochlorines (2), pyrethroids (3)
- **Active Ingredients:** nicotine (4), imidacloprid (4), abamectin (6), methoprene (7A), fenoxycarb (7B), pyriproxyfen (7C), cryolite (9A), *Bacillus thuringiensis* (11A&B), hexakis (12B), propargite (14), diflubenzuron (15), cyromazine (17), amitraz (19), dicofol (20), rotenone (21), azadirachtin (26)

Utah-Registered Insecticides

- **Over 150 total active ingredients in agricultural & commercial products**
- **Over 500 total agricultural and commercial brands**
- **“New” insecticides discussed here include about 29 active ingredients and about 57 brands**

Insecticides - Useful Web Sites

- **Kelly Registrations - State of Utah:**
<http://www.kellysolutions.com/ut/>
Searchable database of Utah-registered pesticides; cumbersome & not user-friendly; sites & pests often too specific
- **IRAC Mode of Action Classification (2004 Version):**
<http://www.irac-online.org/documents/moa/moa.doc>
This version used here for the most part

Insecticides - Useful Web Sites

- **IRAC Mode of Action Classification (2005 Version):**

http://www.iraconline.org/documents/moa/moav4_2.doc

Includes new changes and additions: e.g. Group 18B was Group 26; new Group 26

- **Compendium of Pesticide Common Names:** <http://www.hclrss.demon.co.uk/>
Lists of classes and active ingredients

Insecticides - Useful Web Sites

- **EPA Pesticide Fact Sheets:**

http://www.epa.gov/pesticides/factsheets/chemical_fs.htm

Fact sheets for many new active ingredients

- **EPA Crop Groups:**

<http://www.irac-online.org/documents/moa/moa.pdf>

Definitions of crop groups used in labeling

- **EXTOXNET:**

<http://ace.orst.edu/info/extoxnet/>

Very good information, mostly older a.i.'s

NICOTINOIDS

- Synthetic derivatives of nicotine; a.k.a. neonicotinoids, chloronicotinyls, etc.
- Oldest/best known is imidacloprid (Admire, Merit, Premise, Provado, etc.)
- All included here have systemic activity
- Neuroactive – affect transmission of nerve impulses (post-synaptic membrane)
- IRAC Group 4A
- New active ingredients: acetamiprid, dinotefuran, thiacloprid, thiamethoxam

ACETAMIPRID

- **Nicotinoid – Group 4A**
 - ❑ **Assail - cole crops, fruiting & leafy vegetables, pome fruits, grapes**
 - ❑ **Tri-Star - ornamental herbaceous plants, flowers, trees**
 - **aphids, whiteflies, psylla, leafhoppers, plant bugs, leafminers, codling moth, Colorado potato beetle**

DINOTEFURAN

- **Nicotinoid – Group 4A**
 - **Safari – ornamental herbaceous plants, trees, and turf**
 - **white grubs, masked chafers, lawn billbugs, sod webworms, aphids, scale, whiteflies, leafhoppers, true bugs, leafminers, sawflies, cutworms**

THIACLOPRID

- Nicotinoid – Group 4A
 - Calypso – apples and pears
 - aphids, leafhoppers, mealybugs, plant bugs, scale insects, whiteflies, codling moth, apple maggot, plum curculio

THIAMETHOXAM

- **Nicotinoid – Group 4A**
- **Brand names: Actara, Cruiser, Flagship, Platinum**
- **Actara – apples, cherries, peaches, pears, apricots, peppers, potatoes, sweet potatoes**
- **aphids, leafhoppers, psylla, leafminers, flea beetles, Colorado potato beetle, stink bugs, plant bugs**

THIAMETHOXAM

- ❑ Cruiser – seed treatment of barley, corn, sorghum, and wheat
 - aphids, thrips, leaf & flea beetles, wireworms, cutworms, seedcorn maggot
- ❑ Flagship – ornamental plants
 - aphids, scale insects, mealybugs, whiteflies, white grubs, masked chafers

THIAMETHOXAM

- ❑ Platinum – vegetables including cucumbers, peppers, potatoes, squash, pumpkins, melons, tomatoes
- aphids, leafhoppers, psylla, thrips, flea beetles, Colorado potato beetle, wireworms

SPINOSAD

- A bacterial fermentation product – Group 5
- Bacterium *Saccharopolyspora spinosa* discovered in soil of abandoned rum distillery in the Caribbean
- Metabolites: Spinosyn A & D have the most insecticidal activity
- Neuroactive - mode of action similar to nicotinoids but affects different binding sites

SPINOSAD

- **Brand names: Conserve, Elector, Entrust, Extinsad, Success**
- **Conserve – ornamental herbaceous plants, woody plants, and turf**
 - **cutworms, armyworms, other caterpillars, elm leaf beetle, gall midges, leafminers, sawflies, mites, thrips**
- **Elector – cattle, hogs, poultry, sheep**
 - **horse flies, stable flies, horn fly, chewing lice, sucking lice**

SPINOSAD

- ❑ Entrust – cole crops, legumes, fruiting vegetables, leafy vegetables, root crops, stone fruits, corn, berries
- armyworms, cutworms, leafrollers, leafminers, sawflies, leaf & flea beetles, apple maggot, cherry fruit fly, codling moth , Colorado potato beetle
- ❑ Extinsad –beef, dairy, poultry, sheep
- stable flies, horse flies, hide beetle, darkling beetles

SPINOSAD

- ❑ Success – tree fruits, cole crops, legumes, fruiting & leafy vegetables, root crops, berries, corn
- leafrollers, loopers, cutworms, armyworms, leafminers, leaf & flea beetles, apple maggot, cherry fruit fly, codling moth, peach twig borer, thrips

EMAMECTIN BENZOATE

- **A bacterial fermentation product – Group 6**
- **In the same group as avermectin B1 (abamectin)**
- **A semi-synthetic avermectin derived from fermentation of avermectin B1**
- **Neuroactive – affects ion transfer through cell membranes (chloride channel activator)**

EMAMECTIN BENZOATE

- ❑ Proclaim – cole crops, fruiting & leafy vegetables
- Restricted-Use-Pesticide (RUP)
 - caterpillars, armyworms, loopers, hornworms, corn earworm, diamondback moth

PYMETROZINE

- **A feeding depressant (antifeedant, selective feeding blocker) – Group 9B**
- **Chemical class: pyridines**
- **Precise mode of action (MOA) unknown**
- **Neural or neuromuscular effect – prevents insertion of stylets**
- **Effective only against pests with piercing-sucking mouthparts**

PYMETROZINE

- ❑ Endeavor – ornamental plants including greenhouse uses
 - aphids, whiteflies
- ❑ Fulfill – cole crops, cucurbits, fruiting & leafy vegetables, tuber and corm crops
 - aphids

FLONICAMID

- A feeding depressant (antifeedant, selective feeding blocker) – Group 9C
Chemical class: nicotinoids (systemic)
- Different chemical sub-class and MOA than other nicotinoids
- “Unique MOA” but unspecified or undetermined
- Effect is modification of feeding behavior, leading to starvation

FLONICAMID

- ❑ **Aria – herbaceous and woody
ornamentals**
- **aphids, whiteflies, scale, mealybugs,
leafhoppers, thrips, plant bugs, stink
bugs**

CLOFENTEZINE

- **A mite growth inhibitor – Group 10A (U.S. registration, 1995 or earlier?)**
- **Chemical class: tetrazines**
- **Unknown or non-specific MOA**
- **Acts primarily as an ovicide, with some effect on early instars**
- **Brand names: Apollo, Ovation**

CLOFENTEZINE

- ❑ Apollo – apples, apricots, cherries, peaches, pears
- European red mite, spruce spider mite, McDaniel mite, twospotted spider mite
- ❑ Ovation - various flowers; containerized, nursery & greenhouse uses
- European red mite, McDaniel mite, twospotted spider mite

HEXYTHIAZOX

- **A mite growth inhibitor – Group 10A
(U.S. registration, 1995 or earlier?)**
- **Chemical class: thiazolidines**
- **Unknown or non-specific MOA**
- **Acts primarily as an ovicide, with some effect on early instars**
- **Brand names: Hexygon, Onager, Savey**

HEXYTHIAZOX

- ❑ Hexagon – ornamental fruits & nuts, flowering plants, foliage plants; including greenhouse, nursery
- ❑ Onager & Savey – stone fruits, alfalfa seed, raspberries (Savey only)
- European red mite, McDaniel mite, twospotted spider mite

ETOXAZOLE

- **A mite growth inhibitor – Group 10B**
- **Chemical class: oxazolines**
- **Unknown or non-specific MOA**
- **Acts primarily as an ovicide, with some effect on early instars**
- **Brand names: Tetrasan, Zeal**

ETOXAZOLE

- ❑ **Tetrasan – ornamental herbaceous & woody plants**
 - **European red mite, McDaniel mite, twospotted spider mite**
- ❑ **Zeal – non-bearing fruit & nut trees, strawberries**
 - **European red mite, McDaniel mite, twospotted spider mite**

Transgenic *Bacillus thuringiensis*

- **Biological control agent – insect midgut disruptor; Group 11B2**
- **“Transgenic” insecticides – genes from B.t. implanted in corn**
- **“Crystal toxins” produced by gene regions designated as “Cry” ; different types effective against different pests**
- **Three recent products: Cry1F, Cry1A(b), and Cry3Bb plus Cry1A(b)**
- **Brand names: Herculex, Yieldgard (2)**

Transgenic *Bacillus thuringiensis*

☐ Herculex

- black cutworm, corn earworm, European & southwestern corn borer, fall armyworm, western bean cutworm

☐ Yieldgard Insect Protected Corn BT

- corn earworm, European & southwestern corn borer, fall armyworm

☐ Yieldgard Plus Corn Borer/Rootworm

- corn earworm, Eur. & SW corn borer, northern & western corn rootworm

CHLORFENAPYR

- **Pyrrole insecticides/miticides – Group 13**
- **Chemical class: pyrroles or pyrazoles**
- **Interferes with formation of ATP, which is the “fuel” for muscle contractions**
- **Brand names: Pylon, Phantom**

CHLORFENAPYR

- ❑ Pylon – ornamental herbaceous plants and fruiting vegetables
 - loopers, armyworms, fruitworms, budworms, hornworms, fungus gnats, spider mites, thrips
- ❑ Phantom – indoor sites & outdoor soil treatments
 - ants, cockroaches, termites

NOVALURON

- **Insect growth regulators – Group 15**
- **Chemical class: benzoylureas**
- **chitin synthesis inhibitor – Type 0, Lepidopteran**
- **prevents proper formation of exoskeleton after molting**
- **Brand names: Pedestal, Rimon**

NOVALURON

- ❑ Pedestal – ornamental flowering plants including greenhouse uses
 - whiteflies, thrips, leafminers, armyworms
- ❑ Rimon – ornamental plants, potatoes, sweet potatoes
 - armyworms, Colorado potato beetle, thrips, whiteflies, plant bugs, stink bugs

BUPROFEZIN

- **Insect growth regulator – Group 16**
- **Chemical class: thiadiazines**
- **chitin synthesis inhibitor – Type 1, Homopteran**
- **prevents proper formation of exoskeleton after molting**
- **Talus – cucurbits, lettuce, tomatoes, grapes**
- **scale, leafhoppers, mealybugs, planthoppers, whiteflies**

DIACYLHYDRAZINES

- **New insecticide class – Group 18A (2005)**
- **Disruptors or mimics of the insect hormone ecdysone, which induces molting and metamorphosis**
- **Active ingredients & brand names:**
 - halofenozide (Mach 2)**
 - methoxyfenozide (Intrepid)**
 - tebufenozide (Confirm, Mimic)**

HALOFENOZIDE

- ❑ Mach 2 – ornamental turf
- billbugs, white grubs, masked chafers, sod webworms, cutworms

METHOXYFENOZIDE

- ❑ Intrepid – apples, cherries, peach, pear, leafy & fruiting vegetables, cole crops
- armyworms, loopers, webworms, leafrollers, codling moth

TEBUFENOZIDE

- ❑ Confirm – apple, pear, berries, cole crops, leafy & fruiting vegetables, ornamental herbaceous plants, shrubs, trees
 - leafrollers, webworms, armyworms, cabbageworms
- ❑ Mimic – ornamental shrubs & trees
 - various caterpillars

PYRIDAZINONES

- METI miticides – Group 21
- Mitochondrial Electron Transport Inhibitors (METI)
- Affect the respiratory chain, a.k.a. electron transport chain
- Rotenone has the same MOA (insecticide and fish poison)
- Active ingredients & brand names:
fenpyroximate (Akari, Fujimite)
pyridaben (Nexter, Pyramin, Sanmite)

FENPYROXIMATE

- ❑ Akari – ornamental herbaceous plants, shrubs, trees including greenhouse & interior treatments
 - spider mites
- ❑ Fujimite – apples, pears, grapes
 - spider mites, leafhoppers, pear psylla

PYRIDABEN

- ❑ **Nexter** – apple, apricot, cherry, peach, pear, plum, ornamental herbaceous plants, shrubs, and trees
 - spider mites, aphids, leafhoppers
- ❑ **Pyramite** – apple, apricot, cherry, peach, pear, plum
 - spider mites, aphids, leafhoppers
- ❑ **Sanmite** – ornamental foliage plants
 - spider mites, whiteflies

INDOXACARB

- **Sodium channel blockers – Group 22**
- **Chemical class: oxadiazines**
- **Sodium channels are involved in transmission of nerve impulses and contraction of muscle cells**
- **Brand names:**
 - Avaunt**
 - Steward**

INDOXACARB

- ❑ **Avant** – apples, pears, cole crops, corn, lettuce, peppers, potatoes, tomatoes
- Colorado potato beetle, corn earworm, leafrollers, leafminers, other caterpillars
- ❑ **Steward** – alfalfa
- alfalfa weevil, armyworms

ACEQUINOCYL

- **Mitochondrial electron transport inhibitor (METI) miticide -- Group 24 (2004); Group 20B (2005)**
- **different site of action than METI miticides in Group 21**
- **Chemical class: quinolenes**
- **Affects the respiratory chain, a.k.a. electron transport chain**

ACEQUINOCYL

- ❑ Kanemite & Shuttle -- pome fruits, strawberries, ornamental flowering & foliage plants
- European red mite, spruce spider mite, twospotted spider mite

BIFENAZATE

- **Carbazate miticides – Group 25**
- **Chemical class: carbazates (related to carbamates)**
- **Neuroactive but exact MOA is unknown**
 - ❑ **Acramite – stone & pome fruits, grapes, fruiting vegetables, cucurbits**
 - ❑ **Floramite – ornamental flowering & woody plants, turf**
 - **both labeled for various spider mites**

CLARIFIED HYDROPHOBIC NEEM OIL

- **A botanical insecticide - Group 26 (2004);
Group 18B (2005)**
- **Chemical Class: neem oil derivative;
neem oil = C.H. neem oil + azadirachtin**
- **Disrupter or mimic of the insect hormone
ecdysone, which induces molting and
metamorphosis**
- **Brand Names:Shield-All
Triact**

CLARIFIED HYDROPHOBIC NEEM OIL

- ❑ Shield-All & Triact - alfalfa, small grains & corn, tree fruits, herbs, berries, various vegetables
- aphids, leafhoppers, psyllids, scale, whiteflies, true bugs, leafrollers, leafminers, beetles, fruit flies, mites

SUCROSE OCTANOATE ESTERS

- **Unclassified - no IRAC Group assigned**
- **Chemical class: esters**
- **Active ingredient found on tobacco leaf hairs in a study of their insecticidal effects**
- **Dissolves the exoskeleton (cuticle) of the insect**

SUCROSE OCTANOATE ESTERS

- ❑ Sucroside - very general labeling: field crops, fruit trees, vegetables, ornamental flowers, trees, & shrubs
- adelgids, aphids, leafhoppers, mealybugs, psyllids, scales, whiteflies, plant bugs, caterpillars, fungus gnat larvae, mites

POE ISOCTADECANOL

- **Unclassified - no IRAC Group assigned**
- **Chemical class: alcohol**
- **works by suffocation of larvae & pupae in water; forms a monomolecular film**
- **Agnique, Arosurf, Mosquito Breeding Blocker, Pondmaster Mosquito Control - various aquatic sites**
- **mosquito larvae & pupae**

Beauveria bassiana

- **Biological agent (fungus) - no IRAC Group assigned; natural soil organism**
- **fungal hyphae penetrate the exoskeleton**
 - **Botanigard - alfalfa, small grains, various vegetables, pome & stone fruits, ornamental plants, trees, shrubs**
 - **Naturalis - similar to above, also turf**
 - **aphids & other homopterans, true bugs, grasshoppers, Mormon cricket, caterpillars, beetles, mites**

CODLING MOTH GRANULOSIS VIRUS

- **Biological agent (virus) - no IRAC Group assigned**
- **precise MOA not found in references**
- **kills some larvae outright, reduces overwintering survival, infected adults transmit virus to next generation**
- **Virosoft - apple, pear, plum, prune**
 - **codling moth eggs & larvae**

PHEROMONES FOR FRUIT INSECTS

- Unclassified - no IRAC Group assigned
- Pheromones are natural attractants
- Products specific to certain species or groups: codling moth, oriental fruit moth, peach tree borer, leafrollers
- Checkmate CM, Isomate-C TT, Puffer CM - apple, nectarine, peach, pear, plum, prune, quince, stone fruits
 - codling moth adults

PHEROMONES FOR FRUIT INSECTS

- ❑ Isomate-M 100 - apple, apricot, cherry, nectarine, peach, pear, plum, quince
 - oriental fruit moth adults
- ❑ Isomate-P - apricot, cherry, nectarine, peach, plum, prune
 - peach tree borer adults
- ❑ 3M Sprayable Pheromone - fruit trees, small fruits, vine fruits
 - leafrollers: obliquebanded, Pandemis, etc.