Useful Pest Management Products that Should be Considered by Colorado Nurseries

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What are the insect management products I like to see when visiting the aisles in a retail nursery/hardware store?
A periodic survey that lists active ingredients of OTC insecticides, arranged by active ingredient

Over-the-Counter Insecticides for Home, Yard and Garden Use
2018 Survey, Fort Collins, Colorado

The following is a list of all insecticides found in a survey conducted June 4-11, 2018 in Fort Collins. These are arranged by common name of the active ingredient(s).

The survey included 3 nurseries, 3 hardware stores and 3 box stores. Following each product are indicated the type of store(s) in which it was found (n = nursery; h = hardware store; b = box store).

ACEPHATE (Orthene)
   Bonide Systemic Insect Control (h)
   Bayer Advanced 2 in 1 Systemic Rose & Flower Care (b)

ACETAMIPRIDE
   Ortho Flower, Fruit & Vegetable Ready-to-Spray (n)
   Ortho Rose and Flower Insect Killer Ready-to-Use (h,h,n)
   Ortho Rose & Flower Insect & Disease Control Concentrate (with triticonazole) (n)

ALLETHRIN/TRANS-ALLETHRIN

This is available at the Insect Information Web Site
#1 on the A-List

A broadly labeled horticultural oil
Petroleum Derived Horticultural Oils (Mineral oils, paraffinic oils)
Sesame oil, fish oil

Canola oil

Neem seed oil

Some natural source horticultural oils
Horticultural Oil
Primary Target Pests- Foliar Spray

- Scale insects *in all stages*
- Whitefly nymphs *on the underside of leaves*
- Spider mites
- Aphids *that curl leaves on trees in spring*
Soft Scales
Families Coccidae, Eriococcidae and others

- Soft brown scale (on houseplants in CO)
- Striped pine scale
- European elm scale
- Cottony maple scale
Armored Scales

Family Diaspididae

Pine needle scale

Oystershell scale

Scurfy scale

San Jose scale
Oil sprays can smother some of the eggs underneath the cover of the mother scale.
Crawler stage: The 1st stage of a scale insect that occurs after eggs hatch

Oils – and almost anything else – can kill a scale crawler.
Within about a week the crawlers have either ‘settled’ or died. They remain in place where they settled for the rest of their life.

Recently settled crawlers are good targets of oils
Most current horticultural oils can be used on trees with foliage. Crawlers and young settled scales are targets.
Whiteflies

- Eggs
- Nymphs
- Adults
Oils will not control adult stages of whiteflies
Oils presently are probably the best OTC product for spider mite control.
Preventive management of aphids that curl leaves in spring
Most aphids on trees and shrubs overwinter as eggs laid near buds or on needles.
Stem mother that hatched from the overwintered egg
Subsequent generations develop and curl leaves in mid-late spring
Overwintered egg near the bud – target for dormant season oil application
If eggs are killed, there is no stem mother
No hatching eggs, no stem mother, now spring populations – **No Spring Leaf Curl**
#1 on the A-List

A broadly labeled horticultural oil
Numerous Neem Oil (clarified hydrophobic extracts of neem oil) products are very commonly sold at retail.

OIL, NEEM*

- Bonide Bon-Neem (with pyrethrins and piperonyl butoxide) (n)
- Bonide Neem Oil Concentrate (n,h,h)
- Bonide Neem Oil Ready-to-Spray (h)
- Bonide Neem Oil Ready-to-Use (n)
- Bonide Rose Rx 3-in-1 (n,h,b)
- Espoma Organic Neem Oil 3n 1 (n)
- ferti-lome Fruit Tree Spray (with pyrethrins) (n,n)
Neem

- Extracted from seeds of the neem tree, *Azadirachta indica*
- **Active Ingredients**: *Azadirachtin* primarily, oil fractions have some uses.
- **Mode of Action**: Various – insect growth regulator, feeding deterrent, repellent
Street in Niger lined with a planting of the neem tree, *Azadirachta indica*.

Neem tree outside house on Culebra, Puerto Rico

Photograph by William Ciesla
Neem has many human pharmaceutical uses

- Tooth care
- Diuretic
- Burn ointments
Azadirachtin indica (Neem)

Neem seed extracts contain the active ingredient azadirachtin

Commercially available azadirachtin products
Neem

- Extracted from seeds of the neem tree, *Azadirachta indica*
- Active Ingredients: **Azadirachtin** primarily, oil fractions have some uses.
**Uses of Extracts from Neem Seeds**

**Azadirachtin**
- Disrupts insect growth  
  - Interferes with ecdysone, the molting hormone
- Repellent to some chewing insects

**Neem oil**
- Can smother insects by plugging spiracles  
  - Horticultural oil feature
- Can aid in suppression of powdery mildew fungi  
  - Horticultural oil feature
BioNeem was the only retail product ever found on a retail shelf that had some azadirachtin in it.

No stores in the 2018 survey carried this product.

Some commercially available azadirachtin products (typically about 3% concentration)
“B List” Product

Insecticidal Soap *(potassium salts of fatty acids)*
Environmental Limitations to Effective Use of Insecticidal Soaps

• Soaps are strictly contact insecticides
  – No residual activity
• Efficacy degrades in ‘hard water’
  – Minerals combine to make insoluble soaps
• Rapid drying may decrease uptake and efficacy
Primary Target Pests- Insecticidal Soaps Sprays

• Scale insects
  – Fair for crawlers, Fair for newly settled soft scales, poorer for armored scales

• Aphids
  – Fair (better than oils)

• Spider mites
  – Fair to poor
“B List” Product

Pyrethrins *(pyrethrum extracts)*

An extremely common active ingredient in retail products (ca. 3 dozen products found on retail shelves)
Pyrethrum

*Tanacetum* (= *Chrysanthemum*)
*cinerariifolium*

Pyrethrum (Dalmatian) Daisy

The insecticides known as pyrethrins are extracted from the flowers of pyrethrum daisy.
Pyrethrum

- **Active Ingredient:** Pyrethrins
- **Attributes:** Very fast acting/’knockdown’ activity. Very rapidly degrades in light (hours). Short persistence.
- **Current Uses:** Labeled for use on essentially all crops. Has indoor uses including some around food handling areas.
  - Products that do not contain piperonyl butoxide are often allowable in Certified Organic Production.
Primary Target Pests- Pyrethrins Sprays

• **Chewing insects** (beetles, caterpillars, grasshoppers, earwigs)
  – Fair-good for insects that do not move much. Control is often poor for mobile species.

• **Aphids most other sucking insects**
  – Fair

• **Spider mites**
  – Often worse than poor
Pyrethrins-containing products

- plus sulfur

- plus neem oil

- plus insecticidal soap
“A List” Need

A broadly labeled product that reliably controls most chewing insects

- Historically a role of various organophosphate insecticides (malathion, diazinon, Dursban, Orthene)
- Historically a role of carbaryl/Sevin
- Presently largely filled by pyrethroid insecticides that have persistent effects
- Spinosad an option
- Acetamiprid an option
Pyrethroid Insecticides  
(a.k.a., synthetic pyrethrins)
Pyrethroid Insecticides Found on Nursery Shelves (for plant use)

- permethrin
- bifenthrin
- beta-cyfluthrin
- cypermethrin
- deltamethrin
- lambda/gamma cyhalothrin
Primary Pyrethroid Insecticide Found on Nursery Shelves – *That can be used on Fruits/Vegetables*

- Permethrin
A Pyrethroid Insecticide Found on Nursery Shelves – *That can be used on many fruits/vegetables*

**Active Ingredient:**
Gamma-cyhalothrin
Cabbageworms

Hornworms

Caterpillars

Budworms

Hornworms
Flea Beetles
Grasshoppers
European Earwig
On some plants a persistent pyrethroid type of insecticide can give the best control of Japanese beetle (maybe a week of control)

These are not an option for plants that are in bloom and being visited by bees
What is happening with the insecticide known as Sevin?
Products sold June 8, 2018

- Zeta-cypermethrin
- Carbaryl
History of Carbaryl as Retail Product

• Sold under trade name Sevin since early 1960s
• Widely used as a garden/landscape plant care product from 1960s until early 2000s
• Increased restrictions on use in past decade (e.g., loss of turfgrass sites)
• Apparent removal from market in 2019 by manufacturer and replaced with zeta-cypermethrin
Products offered for sale February 5, 2019

carbaryl

carbaryl
Status of Carbaryl/Sevin?

• There is a transition in the active ingredient of a Sevin branded product sold at retail
• Carbaryl is apparently leaving the retail market (liquids first, dust later)
• Zeta-cypermethrin is replacing carbaryl as the active ingredient in a Sevin-branded product

For the first time since the Sevin brand was introduced into the market over 50 years ago, some formulations will no longer contain the active ingredient carbaryl
Pyrethroid Uses

• Generally broad spectrum, moderately persistent

• Target pests
  – Standards for borer and bark beetle sprays
  – Very strong on most beetles, caterpillars, sawflies, scale crawlers
  – OK on most Hemiptera (e.g., aphids, whiteflies, leafhoppers, bugs)

• Limitations
  – Marginal to poor on spider mites
  – Generally destroy natural enemies
  – Have high hazard to pollinators
Spinosad (spinosyns)

An insecticide derived from microbes (*Saccharopolyspora* spp.)

Spinosad products also found in retail stores under Earth-tone, ferti-lome, Monterey and Ortho brands.

“A List” Product
Spinosad

- Primary target pests:
  - Caterpillars (including tip moths)
  - Sawflies
  - Leafminers
  - Thrips
  - Beetles (fair)

- Can be used on flowering plants if applied at dusk
- Many formulations allow use in Certified Organic production
Spottedwing drosophila (SWD)

*Drosophila suzukii*

A recently established insect in Colorado that primarily damages small fruits (strawberries, raspberries)
Infestations of the developing larvae rapidly soften the fruit.
Management of Spottedwing Drosophila

• Thoroughly and frequently pick ripening fruit
  – Store in refrigerator/rapidly use fruit
  – Destroy culled fruit in manner that kills developing larvae
• Shift to early bearing cultivars
• Insecticides
Management of Spottedwing Drosophila

• Thoroughly and frequently pick ripening fruit
  – Store in refrigerator/rapidly use fruit
  – Destroy culled fruit in manner that kills developing larvae
• Shift to early bearing cultivars

• Insecticide?
  – Spinosad
    – Only applied at evening after bees cease visiting!
Spinosad can be used on flowering plants but must only be applied at dusk, after bees have stopped foraging for the day.
Preventive Use of Trunk Sprayed Insecticides

#1 Treatment used for most Borers and all Bark Beetles

Timed for Egg Laying/Egg Hatch Period!
“A List” Need

A trunk sprayed product to control borers and bark beetles on trees

- Historically a role of some organophosphate insecticides, primarily chlorpyrifos/Dursban
- Present alternative
  - Permethrin
Only one permethrin product sold at retail has a label and use rate that allows effective use against borers and bark beetles!
Systemic Insecticides - A few insecticides have the ability to move into a plant and move systemically within the plant.
Neonicotinoids

• Insecticide class originally developed commercially in the late 1980s

• Mode of action - **Nicotinic acetylcholine receptor agonist**
  • IRAC Mode of Action Group 7A
  • Nicotine mode of action similar

• First new class of insecticide with systemic activity in plants in 30+ years

• Low toxicity to vertebrates accelerated registration as “reduced risk” products
Primary Neonicotinoid Insecticides Used in Tree/Lawn Care

- **Imidacloprid** (Merit, Marathon, Zenith, etc.)
- **Clothianidin** (Arena)
- **Dinotefuran** (Safari, Zylam, Transect)
- **Acetamiprid** (Tristar)
Neonicotinoid Insecticides Sold at Retail

imidacloprid

acetamiprid
Not all Neonicotinoids are alike:

- UV stability
- Water solubility
- Rate of uptake by plants
- Mobilization within plants
- Host range of susceptible insects
Bottom line: Acetamiprid is the only neonicotinoid – and only presently available systemic insecticide – the is useful for a spray application.
“A List” Need

Systemic Insecticide Spray

- Leafminers within a leaf
- Aphids within a leaf curl
- Insects in shoots
Systemic Insecticides – Foliar Applications

Ortho
Isotox Insect Killer
Hi-Yield CYGON 2-E

Ortho
FLOWER FRUIT & VEGETABLE INSECT KILLER
Kills 100+
lasted insects fast
Guaranteed Results!
Acetamiprid has replaced acephate (Orthene) and other organophosphates as a systemic insecticide to be sprayed.
Commercial formulation for ornamentals

Retail formulation

Acetamiprid formulations

Commercial formulation for fruits and vegetables
Acute Toxicity of Neonicotinoid Insecticides to Adult Honey Bees

(Ooral LD50* – micrograms/bee)

- **Acetamiprid** 14.53
- **Imidacloprid** 0.005
- **Dinotefuran** 0.056
- **Thiamethoxam** 0.005
- **Chlothianidin** 0.0003

*The lower the LD50, the more acutely toxic is the insecticide*
Characteristics of Acetamiprid

• Has systemic activity; applied as a spray
• Low hazard to bees
• Broadly labeled for use on fruit crops, many vegetables and ornamental plants.
• Target pests
  – Aphids, scale insects (sucking insects) – Excellent
  – Caterpillars – Good to Excellent
  – Beetles - Fair
Status of Acetamiprid?

• Has been available through retail outlets since 2015
• Rarely found on retail shelves
  – Availability less in 2018 than 2015
• Remains an underutilized product
Another “A List” Need

A soil-applied systemic insecticide that can control insects

• Historically a role of some organophosphate insecticides
  – Acephate (Orthene)
  – Disulfoton (DiSyston)
• Recent alternatives involve *neonicotinoid* insecticides
  – Imidacloprid (only product sold at retail)
Systemic Insecticides
– Soil Applications
Some Over-the-Counter imidacloprid formulations
Imidacloprid has replaced the organophosphates as a soil application.
Soil applications can substitute for whole plant sprays

Soil application of systemic insecticide

Spraying whole plant
Aphids on trees and shrubs
Some gall producing insects on trees (e.g., hackberry psyllid)
Elm Leaf Beetle
Leafminers
Effectiveness of neonicotinoid insecticides against scale insects varies by type of scale and mobility of the insecticide.
Soft Scales - Imidacloprid can be very effective
Armored Scales – *Imidacloprid is not very effective*
Imidacloprid for Borers?

Yes.....but

Yes

No
Imidacloprid will not work well on borers that are the larval stage of moths (Lepidoptera)
Lilac/ash borer larvae
Peach tree borer larval tunneling in base of plant
Zimmerman pine moth injury
Imidacloprid will not work well if the borer spends much of its life in the heartwood of the plant.

This would include most roundheaded borers/longhorned beetles.
Locust Borer
*Megacyllene robiniae*

- Larvae within trunk
- Adult pair on trunk
- Full-grown larvae
- Exterior symptoms on trunk
Imidacloprid soil treatments can work against this type of wood borer.
Four *Agrilus* sp. borers found in Colorado

Top Row - Rose stem girdler (left), Bronze birch borer (right)

Bottom Row – Honeylocust borer (left), Gambel oak borer (right)
Emerald ash borer is a flatheaded borer
Imidacloprid will not work well if there has already been extensive damage to the cambium.
Primary method of imidacloprid application – soil applications for root uptake
Optimal Application – Soil drench within 18-24 inches of the trunk

Yes

No?
Originally, when soil applied systemic insecticides hit the market the recommended application was as a regularly spaced arrangement of injections under the drip line of the tree.

Injections are made at each "X" spaced apart every 2.5-feet. Rings are also spaced apart by 2.5-feet.

Circular Pattern

A circle of 40-ft diameter (i.e., 40-ft canopy spread) covers 1250 sq ft.

Bird's eye views from above the tree looking through the canopy to the ground. The dark spot represents the trunk, while the irregular grey line represents the border of the canopy (the drip line).
There are many roots present near the base of the tree that can allow uptake of a soil applied insecticide.
Soil applications of systemic insecticides should not be made if there are flowering plants at the application site.
Pollinators and Systemic Treatments
Soil Applied Systemic Insecticides and Honey Bees – Targets for Concern

• Plant is heavily used by honey bees as pollen and/or nectar source
  – Risk related to the amount the plant contributes to the overall intake of a specific hive
Top honey bee-visited plants include: most Sedums, most thistles, catmint, *Gaillardia*, most *Agastache*, Blue mist spirea, Russian sage, fruit trees, linden, golden raintree ……..
My greatest concern about neonicotinoids and woody plants - Lindens

Heavily used by bees

Often has problems with linden aphids

Susceptible to Japanese beetle
Soil Applied Systemic Insecticides and Honey Bees – Targets for Concern

• Plant is heavily used by honey bees as pollen and/or nectar source

• The type of application has high potential to cause exposure and harm to the pollinator
  – Risk related to time of application
  – Risk related to inherent hazard of the insecticide to pollinators
  – Risk related to rate applied
2013 Oregon Bumble Bee Kills

Involved use of a highly mobile systemic insecticide (dinotefuran) applied just prior to bloom on plants that are heavily used by bumble bees.
Soil Applied Systemic Insecticides and Honey Bees – Highest Risk Scenario

• Plant is heavily used by honey bees as pollen and/or nectar source
  – Treated plants constitute important part of food being brought to hive

• The type of application has high potential to cause exposure and harm to the pollinator
  – Treatments are likely to result in hazardous levels of residues in pollen and/or nectar
Systemic Insecticides and Pollinators: Bottom Line

Avoid applications to plants that bees visit that are in bloom – or soon will be in bloom
"A List" Need

A systemic insecticide that can be used to control insects on houseplants.
This imidacloprid-containing product can be used on house plants.

This imidacloprid-containing product cannot be used on houseplants.
Other imidacloprid-containing products that can be used on house plants include:

Bayer Advanced 2in1 Insect Control Plus Fertilizer (2.5% imidacloprid)

Bayer Advanced Dual Action Rose & Flower Insect Killer (0.012% imidacloprid)
“A List” Product

A “Bti” product for Mosquito Larvae – and Fungus Gnat Larvae
**Bacillus thuringiensis**

- Derived from a widely distributed soil bacterium
- Active ingredient a toxic protein crystal that destroys cells of the midgut
- Used as a stomach poison

*Bacillus thuringiensis kurstaki* strain – used to control caterpillars
Several Bt strains are present, each with specific activity:

- **kurstaki**, **aizawi** strains (leaf feeding Lepidoptera larvae)
- **tenebrionis** strain (leaf beetles)
- **israelensis** strain (larvae of mosquitoes, gnats, black fly larvae)
Mosquito Life Cycle

- Adult (left)
- Larvae/wrigglers (lower left)
- Pupae/tumblers (below)

Target stage
Fungus Gnats

Very common associates of soil and decaying organic plant matter

Photograph courtesy of David Cappaert, Michigan State University
This formulation now allows use for control of fungus gnat larvae.
“A List” Product

A Slug Control Product
Metaldehyde Products

Iron Phosphate Products
My favorite slug control product – *but only because I like the package!*
Iron Phosphate

Now nearly completely dominates market

Metaldehydro

Formerly dominant, steadily displaced over past decade
Iron Phosphate Slug Baits

This product is combined with spinosad
“A List” Product
A White Grub Control Product
(where local problems exist)
White grubs prune the roots, producing drought stress symptoms
Adults of the primary white grubs of turfgrass

Southwestern Masked Chafer
*Cyclocephala hirta*

Japanese beetle
*Popillia japonica*
White Grub Larval Treatments

- **Insecticides**
  - Imidacloprid (Merit, Zenith, Criterion, etc.)
  - Chlorantraniliprole (Acelepryn, Scott’s GrubEx)

- **Biological Controls**
  - *Heterorhabditis* spp. parasitic nematodes
  - *Bacillus thuringiensis* var. *galleriae* (grubGONE!)
Imidacloprid for grub control

Products include: Bayer Advanced Season-long Grub Control, Bonide Insect and Grub Control, Hi-Yield Grub Free Zone II
Imidacloprid for White Grubs

- Several OTC products
  - Hi-Yield Grub-free zone, Bayer Insect Killer Soil & Turf, others
- Neonicotinoid insecticide with systemic activity in plants
- Relatively slow acting
- Provides control for several weeks

Optimal time for application: Early period of egg hatch – typically late June through mid-July
Systemic insecticides and Pollinators – Should we be concerned about their use on turfgrass?
A key risk to pollinators when using insecticides on turfgrass

Application to flowering weeds
Mowing before application greatly decreases hazard to pollinators!
Anthranilic Diamide Insecticides
**Ryania speciosa**

Botanical source that lead to development of the anthranilic diamides

**Powdered stems are the source of the insecticide** *ryania*.

**Active ingredient:** *ryanodine*
Chlorantraniliprole for White Grubs

- Anthranilic diamide insecticide
  - Limited systemic activity
  - Very low hazard to applicators
  - Very low hazard to bees
- Relatively slow acting
- Provides control for months weeks
- Only one product in OTC market

Optimal time for application: Early period of egg hatch – typically late June through midJuly
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Recommendations for Japanese Beetle Larval Control

• Cultural Controls
• Chemical Controls

• Biological Controls
  – Insect parasitic nematodes (*Heterorhabditis* spp.)
  – *Bacillus thuringiensis* var. *galleriae*
  – Milky spore
Milky Spore for Japanese Beetle?

Used to permanently establish a biological control organism – not useful for immediate control.
Milky Spore for Japanese Beetle?

*Long term: May help produce some reduction in numbers of larvae surviving to adulthood. However, infections typically only affect a small percentage of population.*
“A List” Product

An Effective Wasp/Hornet Spray
Typical Wasp and Hornet Spray Product

- Has a quick knockdown insecticide (a pyrethroid)
- Has a more persistent insecticide (another pyrethroid)
- Has a propellant, often designed to produce directed jet with some force
Control of paper wasps with “wasp and hornet” sprays

Colony is exposed
Generally easy to access
Generally effective with a single application
Control of yellowjackets with “wasp and hornet” sprays

Colony is not exposed and may be hidden deeply
Generally difficult to access
Generally required multiple treatments with persistent insecticides
Yellowjackets almost always nest below ground. The nest are never exposed.
Spraying Wasp Nests

• Best done at night or when temperatures are cool enough to prevent flight
• If treating at night do not hold the light!
“B List” Product

An Effective Yellowjacket Trap
Western Yellowjacket – No. 1 Stinging Insect
Many traps are sold to capture yellowjacket wasps.
The Rescue! yellowjacket trap, baited with heptyl butyrate, works well for capturing yellowjackets.
Traps that caught the most western yellowjackets in 2015 trials

- Rescue! OrnamenTrap (Liquid trap)
- SpringStar (Oak Stump) Liquid Trap
- AlphaScent Lure with Yellow Card
Some traps are *very poor* in capturing yellowjackets.
Most effective use of yellowjacket traps?

Probably early in the year (late April-midJune) targeting overwintered queens
European Paper Wasp
Traps do not capture the European paper wasp or any other paper wasps
The Original
Waspinator
EXCLUSIVELY FROM DEWITT

- No pesticides
- Nothing to clean
- No mess
- Not toxic

Keeps Wasps, Yellow Jackets, and Hornets Away!!!
Trap next to Waspinator

Paired trap out-of-sight of Waspinator
Results – No significant differences in capture of western yellowjackets related to Waspinator proximity
If it sounds too good to be true – it is!
“A List” Products

- Horticultural oil of some type
  - Mineral oil, neem oil, seed oil
- A contact insecticide with some persistence
  - Pyrethroid, spinosad
- A permethrin product for control of borers/bark beetles
- Systemic insecticide used as a spray
- Systemic insecticide that can be used as soil application
- Systemic insecticide that can be used on houseplants
- Bti product for fungus gnats
- Effective white grub control
- Effective wasp/hornet sprays
Two products that it would be good to have sold at retail

• A good product to control spider mites
• A product that can be used to control Japanese beetle on plants in bloom
A product I would like to see available through retail

*Bacillus thuringiensis var. galleriae*

Sold as **beetleGONE!** in commercial/ag markets

Sold as **beetleJUS** in the gardener market