GREENHOUSE CROPS

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The following use patterns are in accordance with labels on commercial and restricted class products registered for use in commercial greenhouses. For additional use patterns refer to section on domestic class products for interior plantscapes and house plants.

It is important to alternate between chemical families to prevent or delay development of pesticide resistance in pest populations.

All chemicals may be phytotoxic to some plants or plant stages or under certain conditions. Consult label for additional information or refer to Alberta Agriculture, Food and Rural Development Garden Fax Leaflet 270/621-1, "Susceptibility of Some Ornamental Plants to Pesticide Injury".

ORNAMENTAL CROPS

APHIDS

Chemical Control -

Active Ingredient	Crop(s)	Application
acephate	rose	64 g AI/100L (hydraulic sprayer) 131 g AI/100 L(mist blower)
acetamiprid	ornamentals	16g/380L
bendiocarb	ornamentals	60-80 g AI g/100 L
diazinon 50% EC	chrysanthemum, carnation, rose	1 L prod./4 L fogging solution or 46 g AI/100 L
dichlorvos	ornamentals	1X 4.5% can/300 m^3 as a smoke 3.5 g/ AI/100 m^3 as a fog 120 g AI/100 l spray
endosulfan	ornamentals	1.25L/100L
kinoprene	ornamentals	25 mL/100L
imidacloprid	herbaceous ornamentals	0.002-0.003 g AI/2.5 cm pot or chemigation (1:10 – 1:200)
malathion	ornamentals	65-125 g AI/100L
naled	roses, cut flowers	8.6g AI/100 m^3 vaporized from heating pipes

nicotine	ornamentals	1 can/300 m^3 as a smoke
pirimicarb	ornamentals	500 g /1000L
pymetrozine	ornamentals	10g/100L
pyrethrins + soap	ornamentals	5L/100L
soap	ornamentals	1 part/17 parts water

Restrictions -

dichlorvos: Shasta and Pink Champagne mums and some varieties of snapdragons may be adversely affected.

endosulphan: Apply to chrysanthemums before flowering. Do not treat Bonnafon mums, mum cuttings, or geraniums within one month of planting.

imidacloprid: Do not apply to foliage. Apply only to soil or soilless media/hydroponic only. Read label for application instructions.

kinoprene: Some poinsettia varieties suffer bract damage, some rose varieties suffer delayed damage.

pymetrozine: Do not apply to poinsettia after bract formation.

soap: Test spray on a few plants to determine if phytotoxic.

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

BLACK VINE WEEVIL

Chemical Control -

Active Ingredient	Crop(s)	Application
endosulfan	ornamentals	1 kg 50W/1000 L
Heterorhabditis heliothidis (nematode)	woody ornamentals	5,000 nematodes/L soil

Restrictions -

endosulfan: Apply to chrysanthemums before flowering. Do not treat Bonnafon mums, mum cuttings, or geraniums within one month of planting.

CATERPILLARS

Chemical Control -

Active Ingredient	Crop(s)	Rate (AI)

acephate	rose	64 g AI/100L (hydraulic sprayer) 131 g AI/100 L(mist blower)
Bacillus thuringiensis var. *kurstaki*	chrysanthemum, rose	Follow label
diazinon	chrysanthemum, carnation	50-75 g AI/100L
naled	roses, cut flowers	8.6 g AI/100m^3 vaporized from heating pipes
tebufenozide	ornamentals	0.5L/ha

Restrictions -

Smokes, fogs and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

CYCLAMEN MITE

Chemical Control -

Active Ingredient	Crop(s)	Application
dicofol	ornamentals	26-35 g AI/100 L
endosulfan	ornamentals	1.25L/1000 L

Restrictions -

endosulfan: Apply to chrysanthemums before flowering. Do not treat Bonnafon mums, mum cuttings, or geraniums within one month of planting.

FUNGUS GNATS

Chemical Control -

Active Ingredient	Crop(s)	Application
Bacillus thuringiensis var. *israelensis*	ornamentals	4 L/1000 L
bendiocarb	ornamentals	100 g AI g/100 L applied to soil
cyromazine	ornamentals	133 g AI/ha
diflubenzuron	ornamentals	18g/1000 L for individual containers

			150g/1000L for coarse spray

Restrictions -

diflubenzuron: Do not apply to poinsettia, hibiscus or Reiger begonia. Apply to moist media.

GREENHOUSE WHITEFLY

Chemical Control -

Active Ingredient	Crop(s)	Application
acephate	roses	850 g/ 1000 L
acetamiprid	ornamentals	80 g AI/1000 L maximum 2 applications /year
bendiocarb	ornamentals	60-80 g AI g/100 L
dichlorvos	ornamentals	1 X 4.5% can/300 m^3 as a smoke 3.5 g AI/100 m^3 as a fog 120 g AI/100 L spray
endosulfan	ornamentals	1 L or 1 kg 50W/1000 L
kinoprene	ornamentals	16-97.5 g AI /100 L
imidacloprid	herbaceous ornamentals	0.002-0.003 g AI/2.5 cm pot or 1:10 – 1:200 (chemigation)
malathion	ornamentals	30g/100m^2
naled	roses, cut flowers	8.6 g AI/100 m^3 vaporized from heating pipes
permethrin	aspidistra, begonia, Boston fern, chrysanthemum, cordyline, diefenbachia, dracaena, ficus, fuchsia, geranium, gerbera, impatiens, petunia, philodendron, poinsettia, rose, sansevieria, spider plant	10 g AI/100 L
pymetrozine	ornamentals	10 g/100 L
pyrethrin + soap	ornamentals	5 L/100 L
pyridaben	ornamentals	142 g AI/1000 L
soap	ornamentals	1 kg/100 L

Restrictions -

dichlorvos: Shasta and Pink Champagne mums and some varieties of snapdragons may be adversely affected.

endosulfan: Apply to chrysanthemums before flowering. Do not treat Bonnafon mums, mum cuttings, or geraniums within one month of planting.

imidacloprid: Do not apply to foliage. Apply only to soil or soilless media/hydroponic only. Read label for application instructions

kinoprene: Apply pre-bloom. Some poinsettia varieties suffer bract damage, some rose varieties suffer delayed damage.

pymetrozine: Do not apply to poinsettia after bract formation. Maximum of 2 applications in a crop cycle.

pyridaben: Maximum of 2 applications per crop cycle.

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure blossoms and foliage is dry before applying treatment.

LEAFMINERS

Chemical Control -

Active Ingredient	Crop(s)	Application
Larvae:		
cyromazine	ornamentals	141 g AI/ha
Adults:		
abamectin	ornamentals	60 ml/100 L
acetamiprid	ornamentals	80 g/ 1000 L
diazinon	azalea, carnation, chrysanthemum	50 g AI/100 L
permethrin	chrysanthemum	10 g AI/100 L

Restrictions –

abamectin: Do not use on ferns or Shasta daisies.

MEALYBUGS

Chemical Control -

Active Ingredient	Crop(s)	Application
bendiocarb	ornamentals	60-80 g AI g/100 L
dichlorvos	ornamentals	1 X 4.5% can/300 m^3 as a smoke 3.5 g AI/100 m^3 as a fog

malathion	ornamentals	65-125 g AI/100 L
naled	roses, cut flowers	8.6 g/100 m^3 vaporized from heating pipes
pyrethrin + soap	ornamentals	5 L/100 L
soap	ornamentals	1 kg/100 L

Restrictions -

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

SCALES

Chemical Control -

Active Ingredient	Crop(s)	Application
acephate	rose	64 g AI/100 L (hydraulic sprayer) 131 g AI/100 L (mist blower)
bendiocarb	ornamentals	60 g AI/100 L
pyrethrin + soap	ornamentals	5 L/100 L
soap	ornamentals	1 kg/100 L

Restrictions -

bendiocarb: Preharvest interval 14 days; re-entry period 24 hours.

SLUGS and SNAILS

Chemical Control -

Active Ingredient	Crop(s)	Application
ferric phosphate	ornamentals	2.5 g/plant

THRIPS

Chemical Control -

Active	Crop(s)	Application

Ingredient		
acephate	roses	850 g/ 1000 L
bendiocarb	ornamentals	60-80 g AI/100 L
deltamethrin	chrysanthemum, cineria, Easter lily, geranium	1.75-2.5 g AI/100 L
diazinon	chrysanthemum, carnation, rose	50-75 g/100 L as a foliar spray or a soil surface spray
dichlorvos	ornamentals	1 X 4.5% can/300 m^3 as a smoke 3.5 g AI/100 m^3 as a fog
malathion	ornamentals	65-125 g AI/100 L
nicotine	ornamentals	1 can/300 m^3 as a smoke

Restrictions -

Smokes, fogs and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

deltamethrin: Do not apply within 7 days of crop harvest. Do not use with fogging machines.

bendiocarb: Preharvest interval 14 days, re-entry period 24 hours.

TWOSPOTTED SPIDER MITE

Chemical Control -

Active Ingredient	Crop(s)	Application
bifenazate	ornamentals	133mL/400L
dichlorvos	ornamentals	1 X 4.5% can/300 m^3 as a smoke 3.5 g AI/100 m^3 as a fog
dicofol	ornamentals	26-35 g AI/100 L
fenbutatin-oxide	ornamentals	25 g AI/100 L
malathion	ornamentals	7-14 g AI/100 m^2
naled	roses, cut flowers	8.6 g/100 m^3 vaporized from heating pipes
pyridaben	ornamentals	142g AI/1000L
soap	ornamentals	1 kg/100 L

Restrictions -

Fenbutatin oxide: do not apply after tight-bud stage in chrysanthemum after pre-bract stage in poinsettia.

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

GREENHOUSE VEGETABLE CROPS

APHIDS

Chemical Control -

Active Ingredient	Crop(s)	Application	Preharvest Interval (days)
diazinon	tomato	50-75 g/100 L	8
diazinon 500 EC	peppers	92 mL product/100 L	5
diazinon 600 EW	peppers	77 mL product/100 L	5
endosulfan	tomato cucumber lettuce pepper	1.1 kg 50W/ha or 50 g AI/100 L	2 2 14 2
imidacloprid	tomato cucumber pepper lettuce	9.6 g AI/1000 plants or 1:10 – 1:200 chemigation	3 3 3 21
malathion	lettuce: head lettuce: leaf	7-14 g AI/100 m^2 65-125 g AI/100 L	7 21
naled	cucumber tomato	8.6 g AI/100 m^3 vaporized from heating pipes	1 1
nicotine	cucumber lettuce pepper tomato	1 can/ 300 m^3 as a smoke	3 7 5 3
potassium salts of fatty acids 20% + pyrethrins 0.2%	pepper	5L/100L	5
soap	vegetables peppers	1 kg/100 L	0 5

Precautions:

Imidacloprid: Do not apply more than once per season. Do not apply to immature plants since phytoxicity may occur.

naled: Some phytotoxicity reported to flowers of cucumber and tomato.

Restrictions -

Smokes, fogs and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before

applying treatment.

CATERPILLARS

Chemical Control -

Active Ingredient	Crop(s)	Application	Preharvest Interval (days)
Bacillus thuringiensis var *kurstaki*	tomato	follow label	1
	Peppers		1
	Lettuce		1
naled	tomato	8.6 g AI/100 m^3 vaporized from heating pipes	1
	cucumber		1
	tomato		1
tebufenozide	pepper	140g A.I./100L	3
	tomato		2
	lettuce		14
(E)-4-tridecen-1-yl acetate 19.29% + (Z)-4-tridecen-1-yl acetate 0.71%	tomato	40g A.I./ha	

Restrictions -

Tebufenozide: Do not use tomatoes for processing.

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

FUNGUS GNATS

Chemical Control -

Active Ingredient	Crop(s)	Application	Preharvest Interval

			(days)
Bacillus thuringiensis var *israelensisi*	tomato Peppers Lettuce tomato	follow label	1 1 1 1

GREENHOUSE WHITEFLY

Integrated Control - with biological agents, see Integrated Control Section.

Chemical Control -

Active Ingredient	Crop(s)	Application	Preharvest Interval (days)
endosulfan	cucumber tomato	1 kg 50W/1000 L	2 2
imidacloprid	tomato cucumber pepper	9.6 g AI/1000 plants or 1:10 – 1:200 chemigation	3 3 3
malathion	lettuce	1.5L/ha	21 (leaf) 7 (head)
naled	cucumber tomato	8.6 g AI/100 m^3 vaporized from heating pipes	1 1
permethrin	cucumber tomato	10 g AI/100 L	1 1
plant products dormant oil	cucumber	1 L/100 L	3
soap	vegetables	1 kg/100 L	0

Precautions-

Plant Products Dormant Oil - May be phytotoxic at higher than recommended concentrations, or to younger leaves at temperatures of 25°C or higher. Do not use within 30 days of application of sulphur containing materials.

Imidacloprid: Do not apply more than once per season. Do not apply to immature plants since phytoxicity may occur.

Restrictions -

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

THRIPS

Chemical Control -

Active Ingredient	Crop(s)	Application	Preharvest Interval (days)
diazinon*	cucumber	11 g/100 m^2 as a soil surface treatment	1
methomyl	cucumber	22mL/100 L	3
nicotine*	cucumber	1 can/300 m^3 as a smoke	3
	lettuce		7
	pepper		5
	tomato		3

Restrictions -

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

*Note: Not effective against western flower thrips.

TWOSPOTTED SPIDER MITE

Integrated Control - with biological agents, see Integrated Control Section.

Chemical Control -

Active Ingredient	Crop(s)	Application	Preharvest Interval (days)
abamectin	pepper	30mL/100L	3
	cucumber		3
	tomato		3
fenbutatin-oxide	cucumber	25 g AI/100 L	3
	tomato		5
malathion	lettuce leaf	7-14 g AI/100 m^2	21
	lettuce head		7
	tomato		3
naled	cucumber	8.6 g AI/100 m^3 vaporized from heating pipes	1
	tomato		1
pyridaben	cucumber	21.3 g AI/100 L	2
	pepper		3

	tomato		2
soap	vegetables	1 kg/100 L	0

Restrictions -

Pyridaben: Do not use pyridaben-treated tomatoes for processing.

Smokes, fogs, and other fumigants: Special protective equipment required and thorough ventilation of house after exposure period. Water plants well, but ensure that blossoms and foliage are dry before applying treatment.

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INTEGRATED CONTROL OF TWOSPOTTED SPIDER MITE AND GREENHOUSE WHITEFLY ON GREENHOUSE TOMATOES AND CUCUMBERS

Parasites and predators in conjunction with chemical insecticides can control whiteflies and twospotted spider mites on greenhouse tomatoes and cucumbers. Chemicals and application methods for these and other pests should be selected to present minimal hazard to the biological agents. Heavily pest-infested areas may require spot treatment but overall sprays should be avoided. The biological agents should be introduced at the first sign of mites or whiteflies or as soon as the crop goes in if previous crops were infested. Introductions onto other than very low initial pest infestations have no chance for successful control.

Whitefly Control

At first signs of whitefly on yellow sticky strips, introduce the parasitic wasp *Encarsia formosa* at a rate of 1 per 4 plants for tomatoes and 1 per 2 plants for cucumbers. Repeat weekly for 9 weeks or until 80% of all whitefly scales turn black.

Spider Mite Control

Introduce the predatory mite *Phytoseiulus persimilis* at the rate of l per plant. Repeat at weekly intervals until established in the crop.

EFFECTS OF GREENHOUSE PESTICIDES ON BIOLOGICAL CONTROL AGENTS

Pesticide	**Application**	**Effect on *E. formosa***	**Effect on *P. persimilis***	**Effect on *A. cucumeris***
permethrin	spray	harmful (36)	harmful (30)	harmful (30)
benomyl	spray	negligible	harmful	harmful
botran	spray	negligible	negligible	negligible
bravo	spray	negligible	negligible	negligible
captan	spray	negligible	negligible	harmful (7)
diazinon	soil drench	harmful (14)	negligible	harmful (7)
dibrom	fumigant	harmful (7)	harmful (7)	harmful (7)
dichlorvos	fumigant	harmful (2)	harmful (2)	harmful (2)

Bacillus thuringiensis	spray	negligible	negligible	negligible
insecticidal soap	spray	harmful (adults)	harmful (0)	harmful (0)
dicofol	spray	harmful (14)	harmful (4)	harmful (4)
methomyl	spray	harmful (31)	harmful (14)	harmful (30)
lindane	spray	harmful (14)	harmful (7)	harmful (20)
malathion	spray	harmful (14)	harmful (14)	harmful (14)
mancozeb	spray	negligible	negligible	harmful
maneb	spray	negligible	negligible	negligible
micronasul	spray	negligible	negligible	negligible
nicotine	fumigant	harmful	negligible	negligible
parathion	fumigant	harmful (14)	harmful (7)	harmful (7)
petroleum oil	spray	harmful (0)	harmful (0)	harmful (0)
rovral	spray	negligible	harmful (7)	harmful
carbaryl	spray	harmful (14)	harmful (7)	harmful (7)
sulphur	dust	negligible	negligible	harmful
sulphur	fumigant	negligible	negligible	negligible
tedion	fumigant	negligible	negligible	negligible
endosulfan	spray	harmful (20)	harmful (7)	harmful (7)
endosulfan	drench	harmful (2)	negligible	harmful (2)
Endex	spray	negligible	negligible	negligible

Note: Brackets indicate residual toxicity to bio-control agent in days at 20°C. For example, insecticidal soap is listed as "harmful, adults (0)", so sprays of this pesticide will only kill adult stages of predators and parasites. It has "0" days residual toxicity so bio-controls could be re-introduced the same day without harm.

References -

1. B.C. Dept. Agric. Nursery, Greenhouse Vegetable and Ornamental Production Guide 1988/89.
2. Steiner and Elliott, Biological Pest Management for Interior Plantscapes, AEC, Vegreville 1987.