General Information

INTEGRATED PEST MANAGEMENT

Note: *The following section on Integrated Pest Management (IPM) is directly from the Vegetable Guide. At present there are no specific guidelines for ginseng and not all of the information will apply, but is good general knowledge.*

Integrated pest management (IPM) is a decision-making process that uses all necessary techniques to suppress pests effectively, economically and in an environmentally sound manner. The elements of integrated pest management include:

- Planning and managing ecosystems to prevent organisms from becoming pests.
- Identifying potential pest organisms.
- Monitoring populations of pests and beneficial organisms, pest damage and environmental conditions.
- Using injury thresholds in making treatment decisions.
- Reducing pest populations to acceptable levels using strategies that may include a combination of biological, cultural, mechanical, behavioural and, when necessary, chemical controls.
- Evaluating the effects and efficacy of pest management practices.

In the Fraser Valley most lettuce, onion, carrot and potato fields are monitored to detect insect pests and diseases such as potato late blight. In general, growers have reduced the number of pesticide applications per season without increased losses due to pest damage. This service is available commercially on a fee basis to Fraser Valley and Vancouver Island growers.

In the ginseng industry there are beginnings of an IPM program, where people are hired to walk gardens and report their findings. There are also companies that have started to do this on a fee for service and will come according to contract, walk the gardens and make reports.

BENEFICIAL INSECTS

Beneficial insects belong to three categories: predators, parasites and pollinators. Monitoring and managing beneficials is an important part of an IPM program. In many cases, if predators and parasites are present in large enough numbers spraying is not necessary. However, beneficials can sometimes be an unacceptable contaminant in harvested crops and sprays must be used to kill the pest. If the pest is killed beneficials will not build up.

Predators prey on and eat pests. Important beneficial predators on vegetable crops include ladybird beetles and larvae, lacewing larvae, syrphid fly larvae and ground beetles.

Parasites live in or on a pest, weakening and finally killing it. They are often too small to be seen, but play an extremely important role in keeping pest populations down. Important vegetable pest parasites include the Ichneumonid wasps which parasitize caterpillars and the Braconid wasps which parasitize aphids and other pests.

Learn to identify important predators and parasites. When possible select pesticides which will not kill beneficials. For example, Pirimor is the preferred product for control of aphids on potatoes, because it is very selective and will not harm beneficials.

INSECT MANAGEMENT

- In planning the insect control program, use the pertinent publications listed in this guide.
- Examine plants often throughout the growing season to find insects in their earliest stages. The best control is usually achieved when insecticides are applied to the young stages of insects.
- On some crops, one insecticide will control more than one insect. Choose the control for your main insect pest, then see whether or not it will control the others.
- Some of the insecticide recommendations in this guide are expressed in ranges. Use lower rates and volumes when plants are small; use higher rates and volumes as the size of the plants increases. For best results spray both sides of the leaves.
- Practise crop rotation whenever possible. Growing crops that are not susceptible to the same pests prevents buildup of serious pests.
- Practise sanitation (destruction of crop refuse and good weed control) to help prevent some stages of the insect pests from completing their life cycle or from being protected during the winter. Cull piles are a primary source of pest breeding and subsequent field infestation.

DISEASE MANAGEMENT

Measures that may be taken to control vegetable diseases include:

- Prevention of damping-off through use of fumigated or steamed seed beds, soil drenches, proper watering and humidity conditions, and seed-treatment fungicides;
- Hot-water treatment of seed for elimination of seedborne diseases;

- Rotation of crops so that those susceptible to the same diseases are not planted year after year in the same field;
- Sanitation (destruction of crop refuse) to reduce the carry-over of diseases to subsequent crops;
- Isolation, roguing and control of insect vectors to minimize the spread of virus diseases;
- Use of resistant varieties; and,
- Use of fungicides to protect against fungus diseases.

WEED MANAGEMENT

- Prevent the introduction of new weeds. Use clean certified seed for green manure crops. Use only well rotted manure.
- Prevent weeds from setting seed. Many common weeds produce more than 20,000 seeds per plant. Practice total farm weed control by controlling weeds on fence lines, irrigation ditches, farm roads, around yards and buildings and equipment storage areas.
- Practice crop rotation to discourage buildup of specific weeds. Repeated planting of the same crop favours development of insects and diseases. This leads to weak or patchy stands that are easily invaded by weeds.
- Learn to identify weeds, particularly at the seedling stage. Know which weeds will and which will not be controlled by various herbicides. For example: hairy nightshade is not controlled by Sencor; shepherd's-purse is not controlled by Treflan.
- Apply registered herbicides at the recommended stage of crop or weed development:
  - Pre-plant — before seeding.
  - Pre-emergence — after planting but before crop or weed emergence.
  - Post-emergence — after the crop or weed has emerged. Herbicides are often more effective on young, rapidly growing weeds. Learn to identify leaf stages. For example: Poast must be applied at the 2-5 leaf stage of barnyard grass for the best control.

CROP INJURY FROM HERBICIDE RESIDUES

Plan your crop rotation. A number of herbicides may remain in the soil and may affect crops in the year following use. Others may be retained and affect crops planted later in the same year. Atrazine and simazine residues following corn or strawberries may be damaging to other crops in the year following use. CIPC has injured other vegetables planted the same season following its use on onions. Sencor has injured onions on muck soils planted the year following its use. Check the herbicide label for such residue injury possibilities.

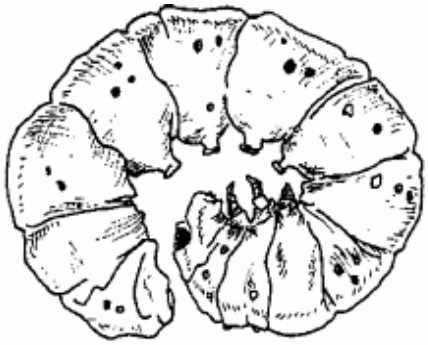
SPREADER/WETTING AGENTS

Spreaders (wetting agents, surfactants) are spray adjuvants that are meant to aid in the distribution, coverage and effectiveness of sprays on the plant. Waxy or hairy plant surfaces are difficult to wet with sprays. It is on plants like this that spreaders are of particular benefit. Use the spreader or adjuvant recommended on the label. Some labels will give recommendations to not use anything — read the label.

General Pests

Note: *the publication 'Major Insect and Allied Pests of Vegetables in British Columbia' is available for identification and life cycles of many of the common insect pests. It is available from Crown Publications, 521 Fort St. Victoria British Columbia V8W 1E7, 604-386-4636. A fee of $8.95 + GST is charged.*

CUTWORMS



Cutworms are greyish, fleshy, six-legged worms up to 5 cm long which curl up when disturbed. Plants may be chewed off above or below ground and may be damaged higher up by climbing cutworms. An indication of cutworms will be a young 1 or 2 year old plant that is wilting and falling over that is not attached to the root. The plant top may even be pulled into the mulch. If the wilting is due to a disease, the stem will still be attached to the root only damaged and unable to transport nutrients and water.

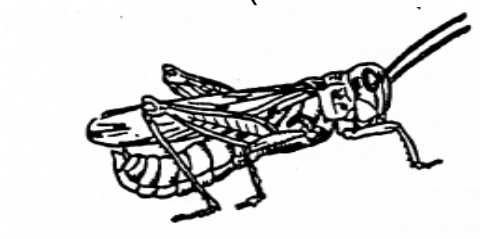
Control — There is one chemical, Pounce, registered for cutworm control in ginseng gardens. Pounce is applied at 180-390 mL/ha with higher rates for heavy infestations or more mature worms. (See page xx for more complete information.) The following farming practises may also help:

- keep the soil well cultivated the summer before planting to reduce food sources
- seed late in the season so adults will not have anything to lay eggs on
- use controls on other areas and crops around the garden

- life cycle timing is critical for any kind of control
- for very small gardens close to a power source, bug zappers will attract and kill cutworm moths.

Around the perimeter of the garden a product like Sevin XLR could be used. Consult label for specific rates.

GRASSHOPPERS (INTERIOR ONLY)



Ginseng may be attacked by young wingless grasshoppers in May or June. Winged grasshoppers feed from mid-summer until fall.

Control — Around the garden area as no controls are registered for use on ginseng.

Spray when grasshoppers are small for best results. Apply in 50 to 100 L/ha (20 to 40 L/acre) of water.

Malathion 500 EC at 2.1 L/ha (0.8 L/acre) or Malathion 850 EC or Cythion 1000 at 1 L/ha (400 mL/acre). Best control is obtained when temperature is above 20°C;

Or Cygon 480, Dimethoate 480 or Lagon 480 E at 425 mL/ha (170 mL/acre);

Or Sevin XLR at 2.5 L/ha (1 L/acre) or Sevin 50 W at 2.25 kg/ha (0.9 kg/acre).

Or Eco Bran Grasshopper Insecticide* at 2-4 kg/ha broadcast evenly over the infested areas. Use the higher rate for older grassshopeers or severe infestations.

This may not be affective as adult grasshoppers can fly and can get into gardens in this manner. They are not usually a big problem.

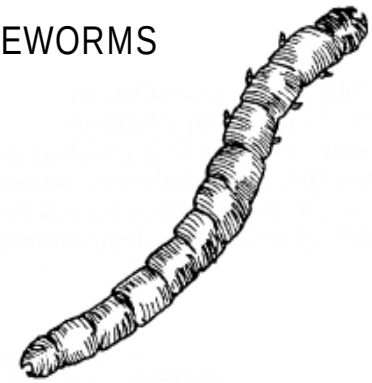
* Available from Peacock Industries, Hague. Sask.

LEAFROLLERS

This insect pest is more of a problem in Ontario than in British Columbia, but it is present here. It is the larvae that causes the concern and the only stage which can be controlled by this pesticide. It can be controlled by using DiPel ® 2X DF at label rates.

See information on page 153A in the Appendix. The label is always the final authority.

WIREWORMS



Wireworms are yellowish-brown, shiny, slender, hard-bodied worms 5 to 25 mm long, which bore into seeds and seedlings and destroy them. In heavy infestations, they will feed on established plants and greatly reduce the yield and render root crops and potatoes unmarketable.

It is very difficult to control wireworms once they are feeding on the roots. Determine the presence of wire-worms before planting a susceptible crop. In South Coastal areas, our native wireworm and two wire-worms that have been introduced from Europe stay within plough depth all year. After ploughing and before planting, baits of whole wheat flour can be used to determine the presence of wireworms. This is done by placing 30 g of flour at a depth of 10 cm in the soil using a hand corn planter or a shovel and marking the location of each bait with a stake. To obtain an accurate reading, 30-50 baits should be used per hectare.

Four days later, dig and examine the baits for wire-worms. An average of one or more wireworms per bait can cause severe damage to susceptible crops such as corn or potatoes. Baits can be used from April to September in the Lower Fraser Valley, but are not effective under cold, wet conditions or very dry conditions. Wireworms take 2 to 6 years to mature, so infested fields can remain a problem for several years. Fields adjoining an infested field should be checked before planting. The natural habitat of wireworms is sod. Populations increase under these conditions. To date, the European wireworms have not been found in the agricultural areas of the Interior.

All the methods of detection outlined for the Lower Fraser Valley are also effective in the Interior except that the wireworms in the Interior may descend to a depth of 60 cm in the fall and may not return to near the surface until the soil warms up sometime in May. Attempts to determine the presence of wireworms in these areas before this time may indicate a lower population than actually exists.

Control — If cover crops are grown prior to seeding ginseng, use a seed treatment that contains lindane. This practice is about the only control available and will prevent wireworm populations from building up.

Note: Do not use dyfonate as it is residual and will be absorbed by the ginseng plant.

OTHER INSECTS

Weevils, white grubs, aphids, and flea beetle have been observed on ginseng plants or in the soil but have not been an appreciable problem to date. No aphid, leafhopper or whitefly infestations have been observed on ginseng to date, which is very nice since these are difficult insect problems on many plants.

SLUGS

These slow-moving, soft-bodied, slimy, legless creatures are found in many shapes and sizes . They eat holes in leaves and leave a trail of mucus, which makes the plants unsightly. They are not a problem in every ginseng garden, but continual checking should be done as they can multiply quite quickly. Remember, you have just built 'slug heaven'. They feed at night so will be hard to find in the daytime.

Control — Slug Bait Pellets: PCP No. 10304. Place small mounds of a metaldehyde based slug bait at intervals around the perimeter of the garden. Use 500 gms of product for every 120 m^2 (1300 ft^2) . Dogs and cats are attracted to metaldehyde baits. Keep pets out of treated areas. Keep away from children, poultry, and domestic animals.

Bait Stations in Gardens — Slug bait containing metaldehyde should be used only in bait stations. Bait stations are most effective placed about 1 m apart and covered.

Cover the bait with boards or other material to preserve the bait longer. This will also attract the slugs to the bait as they seek shelter under the boards during the day. Pets will also be denied access to the bait.

Animals and Animal Damage

FIELD MICE (VOLES)

Field mice, also known as voles, are small rodents (about 13 to 23 cm long) with small, furry ears, blunt snouts, and relatively short tails. They frequently damage potatoes, carrots, and other root crops, and may also damage above ground plant parts. They will also feed on ginseng seeds. Their numbers fluctuate greatly, and damage can be severe when numbers are high.

Control — A combination of cultural control methods and poison baits may be needed to achieve satisfactory control.

- Cultural Control Methods— Field mice avoid areas that do not provide adequate cover. Removal of tall grasses and weed patches adjacent to ginseng gardens, by the use of herbicides or mowing, will reduce the number of mice in the area. They will not be attracted to a site that is kept cultivated for a summer in preparation for ginseng. They will move in though as soon as the mulch is applied if they are in the area.
- Poison Baits — Poison baits should be placed in covered bait stations to protect them from the weather and to prevent accidental poisoning of other animals. The disappearance of the contents will indicate that mice are still present. Bait stations can be easily built from metal pipes, tin cans, and pieces of wood, or may be purchased commercially. They should be placed at 3-4 m intervals in areas where there are burrows or other signs of mouse activity. Weatherproof baits should be used. Use one of the following according to label directions:
  - diphacinone (Ramik Brown, Dipha-Tox) — a multiple-dose rodenticide.

Warning: *Diphacinone bait is highly toxic to dogs.*

Or *chlorophacinone (Rozol, KSC5) — a multiple-dose rodenticide.*

Or *zinc phosphide (Mouse Bait 2, ZP, Z-Phos) — a single-dose rodenticide.*

For further information consult 'Rodent Control on Agricultural Land in British Columbia: Central and Southern Interior Districts'.

POCKET GOPHERS (INTERIOR ONLY)

Pocket gophers are burrowing rodents and can cause severe damage by feeding on roots. They live in underground burrows. Excavated earth is pushed to the surface in small mounds. These will feed on ginseng and need to be eradicated before seeding. The area around the garden needs to be kept free of them so they will not be reintroduced.

Control — Use a hand-probe when infestation is light or as a cleanup operation between burrow-builder treatments. Probe opposite and about 30 cm from the V-shaped indentation on the side of a mound. The probe will drop about 10 to 20 cm when a burrow has been located. Apply strychnine-treated milo

seed (Elston Gopher Getter) with a mechanical hand-probe dispenser. Leave probed hole open.

- Burrow Builders/Mole Plows
  Are mechanical devices pulled behind a tractor that build a tunnel at a suitable depth below ground and automatically drop poison bait at set intervals.

  Apply Elston Gopher Getter (0.35% strychnine bait) at 1 to 2.25 kg/ha (.4 to .9 kg/acre)

Warning: Elston Gopher Getter (strychnine) is extremely dangerous and must be stored out of reach of children and pets.

Or *zinc phosphide 2% (Mouse Bait 2, ZP, Z-Phos) at 5 mL per probe hole.*

- Traps
  Use pocket gopher traps (Victor wire or California Pocket Gopher Traps) where infestations are light or in areas where poisons cannot be used.

See publications

- *Rodent Control on Agricultural Land in British Columbia* and
- *The Design and Use of a Home-made Hand Probe.*

SNAKES — VENOMOUS AND NON-VENOMOUS

Note: All snakes are protected under the BC Wildlife Act and must not be killed.

A concern that has often been expressed is the presence of snakes in the mulch under the plant canopy. The shade cloth and mulch probably gives them a cool respite from the hot sun. This may not seem like a major factor except where rattlesnakes are found. It would be wise to ensure that the local hospital can treat snakebite and have someone on the farm who knows what to do. Rattlesnakes have been found in a few gardens in British Columbia. The Northern Pacific Rattlesnake is the only venomous snake in British Columbia.

For more information on the '*Northern Pacific Rattlesnake*' go to http://www.agf.gov.bc.ca/speccrop/rattle_facts.pdf .

DEER AND BEAR

In the past 15 years of growing ginseng we have received no reports of bears digging up and eating ginseng. There certainly is lots of opportunity, as bears are abundant in the area.

Deer damage on the other hand is quite variable. There seems to be an area difference and a species difference. Mule deer have not been a problem anywhere that we are aware of. White tail have been a problem in some gardens in the Rock Creek/Midway area in southern British Columbia. Light fencing around the gardens seems to deter deer. Growers in many other areas find deer lying in the gardens but not eating the plants or roots.

PHEASANTS

There has been one instance of a garden near an area where a high pheasant population exists, where the birds wandered through and ate or snapped off the tops of some first year plants. The major damage here was the birds scratching in the mulch for food or dusting potential. This was controlled by using some light chicken wire or light netting around the garden but was a nuisance to remove for spraying.

STARLINGS AND WHITE CROWNED SPARROW

These two bird species have decided that ginseng can be a source of food. Starlings will probe along the side of a root and then pull it up, eating the bottom off the root. There is a starling trap that can be made if this becomes a big problem. Only one grower to date has had this concern. See the publication 'Bird Control' published by the British Columbia Ministry of Agriculture, Food and Fisheries.

The other bird species that likes to eat ginseng is the White Crowned Sparrow. It will pick the tops off or partly off one and two year old plants and eat them. They will also scratch in the mulch and find new plants before they emerge. This has an added problem in that they are a migratory species and travel in flocks from a few to thousands. The only feasible control for this bird is to put a fine bird netting around the garden while they are in the area.

Weeds

PREPLOW CLEANUP OF PERENNIAL WEEDS

Clean up of quack grass, Canada thistle, curled dock and other persistent perennial weeds prior to planting of most crops is recommended. Cultivation the previous season during late summer and fall can be effective in dry weather. The following herbicides may also be used:

Roundup or Touchdown have shown to be very effective either as a fall or spring treatment. It is inactivated by soil contact hence is not residual, is very effective on many perennial weeds and is registered preplow prior to many crops. Its use at rates of 4.7 to 7 L/ha (1.9 to 2.8 L/acre) provides good control of Canada thistle and perennial sow thistle in the bud stage, or, quack grass in the 15 to 20 cm stage of active green growth. Higher rates, 7 to 11.5 L/ha (2.8 to 4.6 L/acre) may be needed for other perennial weeds such as field bindweed and dock species. Use in 200 to 300 L/ha water (80 to 120 L/acre). Excess water will result in runoff and reduced control. Allow 7 to 10 days before cultivating.

General Ginseng Disease Management

DISEASE PREVENTION MEASURES

It is much easier to prevent disease problems than to try and fix them. The following measures will help prevent diseases:

- choose sites with good drainage, and a slight slope
- choose sites with adequate air movement, that are not extremely windy
- choose smaller garden sizes rather than large to avoid dead areas in the middle with no air movement
- use clean, washed sand with low silt content for stratifying seed and check seed frequently, discard rotted seed
- test the soil for nematodes and soilborne insects such as wireworm and cutworm
- fumigate if necessary
- after fumigation, re-test soil to ensure nematode numbers are reduced
- avoid tracking or carrying untreated soil onto the fumigated site
- raise beds to provide good water drainage
- prevent damping off by using moderate seeding rates
- spread straw evenly
- practice good sanitation by cleaning equipment and shoes when moving between gardens
- regularly monitor the crop to detect diseases or other pests and problems early; maintain accurate records
- irrigate early in the day so foliage can dry during the day
- apply protectant fungicides before periods of rain, and ensure there is adequate time for the spray to dry onto the plants
- maintain good cultural practices for plant health, i.e., plant and nutrition, irrigation and weed control

When diseases occur, the following will help reduce disease severity:

- identify disease problems promptly so you can choose appropriate control measures
- work in the healthy gardens before moving to infected gardens
- if *Alternaria* has occurred, consider removing the old stems and leaves from the garden. The fungus overwinters as mycelium which you can see as large black patches on the stem. In a small garden removal of plant tops and all the straw mulch, then replacing with new mulch, may be helpful.

SITE SELECTION

When establishing a ginseng garden, site selection is critical to success. Choose sloping land with good soil and air drainage. The soil should be a sandy loam to loam that drains well. British Columbia's arid interior with hot, dry weather should contribute less to disease problems than cooler, wetter locations.

Avoid poorly drained heavy soils and uneven terrain with hollows where soil moisture will accumulate and contribute to damping-off and root rot. See the section on Site Selection for more detail.

PURCHASING SEED

Use only the highest quality seed available. There is little information known on which fungi are carried on or in the seed, and whether they survive the stratification process. However, *Rhizoctonia* can invade and infect ginseng seed in the seed-box. *Cylindrocarpon*, *Fusarium* and *Rhizoctonia* have been found in partially rotted seed that does not float. Not only will this seed fail to germinate, but it can also be a source of infection for neighbouring seeds and seedlings.

Alternaria panax and other foliar disease fungi may also be introduced on seed. Seed should be clean and should not carry pieces of debris that could contaminate your garden.

Infected seed will often float; do not plant floaters. If a significant number of seeds float there are likely to be many other seeds which are also infected but do not float. To detect rotted seeds from those that do not float, it is wise to slice open a sample of seeds and look for rot. Sample approximately 300 to 400 per stratification box or seed lot to determine the level of infection. Rotted seeds can be soft and cheesy, or brown/black inside. Remove and discard rotting seed. It is not possible to determine which organism(s) are responsible for the rots by symptoms alone. Seeds with protruding orange-red "pustules" are contaminated with fungi that may be related to those associated with disappearing root rot or rusty root. Do not use these seeds.

SEED TREATMENTS

Seed stratification can be tricky. It is important to monitor the seeds in the stratification seed-box to ensure conditions are optimal. Place the boxes in a well-drained location, in an area that does not receive runoff from surrounding areas. Pathogenic soil fungi can be carried in runoff water from garden soils, or other areas, to the seed box. Do not bury boxes in the same location each year as this will increase the population of pathogenic fungi. All soils contain some measure of damping-off fungi, so it is important to prevent conditions that are conducive to their development. It is probably a good idea to surface disinfect the stratification boxes each year as well. See page 129 for possible products to use.

Sand selection is critical. The seeds in the seed-box must have adequate oxygen to survive or they will die. The presence of silt in the sand mix or very fine sand will impede water drainage and air movement which contributes to anaerobic conditions. Prolonged rainfall can also contribute to anaerobic conditions, especially if the sand does not drain well. All you will have left is a pile of rotting seed after saprophytic fungi and bacteria cause decay in the dead seed.

There are no legally registered seed treatments for ginseng seed. Even the formaldehyde treatment as a surface disinfectant is not technically legal. Formaldehyde may reduce some seed contamination but will not cure seed that is rotten inside. Some people have used thiram, or carbathiin plus captan just prior to seedling but it is not known if the fungicide residue will persist from seeding in August and September to germination in March when damping-off organisms become active.

DISEASE IDENTIFICATION

When you encounter a problem that you are not familiar with, a sample of affected plants and roots should be sent to a plant diagnostic lab for identification. Good samples contribute to a good diagnosis. The sample should include several plants with symptoms varying from slight to more advanced. Dig the sample with a hand trowel or shovel and gently knock the soil off. Do not pull plants out as infected roots will be torn off the sample and remain in the ground where they are no use to the lab. Keep the entire plant intact, and if possible put a plastic bag around the roots and secure at the crown. Put the entire sample in a plastic bag without any moist paper towel. Send in a box with packing material so the sample does not get crushed. Including a frozen cold pack with the sample will help. Identify specifically what you are concerned about, i.e., plants are wilting, stunted or have leaf spots. Provide a detailed history of the sample and describe the site and symptoms. All the labs mentioned below have a fee-for-service. The British Columbia Ministry of Agriculture, Food and Fisheries Lab Submission forms are available at any British Columbia Ministry of Agriculture, Food and Fisheries office and should accompany all samples. Samples can be sent to:

General Disease Diagnosis:

British Columbia Ministry of Agriculture, Food and Fisheries
Plant Diagnostic Lab
1767 Angus Campbell Road
Abbotsford, British Columbia V3G 2M3
Telephone: 604 556-3126
Fax: 604 556-3030

British Columbia Ministry of Agriculture, Food and Fisheries Lab Fees are:

Urgent – $32.10

Routine – $21.40

Casual – $16.05

All specific tests such as insect identification are $2.00 plus $10.00 (accession fee) + 7% GST

Lab form are also on the website at www.agf.gov.bc.ca/cropprot/lab.htm

IG MicroMed Environmental Inc.
190-12860 Clarke Place
Richmond, British Columbia V6V 2H1
Telephone: 604 279-0666
Fax: 604 279-0633

Virus Testing:

Phytodiagnostics Co. Ltd.
9381 Ardmore Dr.
North Saanich, British Columbia V8L 5G4
Telephone: 250 655-1444
Fax: 250 665-3115

Definitions of words used in the following key

LEAFLET – one of the group of leaves on the same leaf petiole. A two-year old plant usually has 2 leaves and 6 – 10 leaflets (see figure 2, page 5).

LESION – a localized area of discoloured, diseased tissue

MYCELIUM – the threadlike body of the fungus: individual strands may resemble spider webs

SCLEROTIA – bodies made of compact masses of mycelium which have a dark rind and resemble mouse droppings; these fungal structures are able to withstand unfavourable conditions.

How to Use this Key: (Table 20)

If for example you have a wilting three year old plant. Go to number 1 (for symptoms on leaflets). This tells you to go to number 11. At 11, you need to determine if there are spots or blotches on the leaves. There are none, so go to number 13. At 13, you follow directions for leaflets wilting; go to number 14. There are no water-soaked blotches, so you need to look at the roots for the rest of the selections.The roots are starting to rot, so go to number 16. The roots are beige and rubbery, with an unpleasant odour. The plants are wilting because of Phytophthora root rot. Refer to the appropriate disease section for more information.

Table 20. Diagnostic key of ginseng diseases

		Refer to	
1.	Symptoms on leaves or leaflets	go to No. 11	
2.	Symptoms on roots	go to No. 16	
3.	Symptoms on seedlings	go to No. 18	
4.	Symptoms on stems, flower stalks	go to No. 21	
5.	Symptoms on flowers	go to No. 22	
6.	Symptoms on berries and seed heads	go to No. 23	
7.	Symptoms on seeds	go to No. 24	
8.	Symptoms on harvested root	go to No. 25	
9.	Plants fail to come up in spring	go to No. 26	
10.	• Straw has strange black or yellow or white slimy growth; ginseng plants not infected by this growth	Slime Mold	pg 113
	• Straw has green growth on surface	Algae; Moss	
11.	• Leaves with distinct spots or blotches	go to No. 12	
	• Leaves without distinct spots or blotches	go to No. 13	
	• Leaves with white powdery growth	Powdery Mildew	pg 112
12.	• Leaf spots are light to dark brown surrounded by a yellow halo; may have concentric rings; angular, irregular or wedge-shaped	Alternaria Blight	pg 101
	• Leaf blotches are initially olive-green and water soaked and become tan-coloured and brittle when dry; blotches often start at the leaf edge; may have concentric rings; irregular shape	Botrytis Blight	pg 103
	• Entire leaflets wilt, large water-soaked blotches present, later leaves become brown and dry up	Phytophthora Blight	pg 109
13.	• Some or all leaflets wilt	go to No. 14	
	• Leaflets not wilting	go to No. 15	
	• Leaf margins are white, papery, or the centre of the leaf has a white, dry patch	Sun Scorch	pg 119
14.	• Large water-soaked blotches present, later leaves become brown and dry up	Phytophthora Blight	pg 109
	• Roots starting to rot	go to No. 16	
	• Roots not rotting	go to No. 17	
	• Stems have tan lesions	Alternaria stem blight	pg 101
15.	• General yellowing of plants	Nutrient deficiency	pg 46
	• Leaflets small; tissue between veins is white	Possible zinc deficiency	pg 46
	• Leaf edges are white, burned	Ridomil 2E injury	
	• Red spots or ring spots on leaflets of 1 or 2-year olds	Dithane injury	
	• Leaflets with small, round holes	Flea beetle damage	pg 92

16.	• Roots are beige and rubbery; vascular ring is brown; smaller roots have rotted; the inside becomes soft and can be squeezed out of the root like toothpaste; may have unpleasant odour	Phytophthora Root Rot	pg 109
	• Roots have firm, dry, reddish-brown rotted areas that have usually started from the bottom of the root; root can rot away completely	Rusty Root	pg 113
	• Roots have white fungal mycelium on the surface and possibly hard black structures up to 1.5 cm long; the root is soft and has an unpleasant odour	Sclerotinia Root Rot	pg 113
	• The crown has rusty-orange rotted areas, that may include the bud	Rhizoctonia Crown Rot	pg 112
	• The roots have been chewed	Slugs; Wireworms	pg 91-92
17.	• Plants in patches are wilted, but recover after irrigation	Water / Drought stress	pg 119
	• Seedlings have constricted wounds on the lower stem	Damping-Off	pg 105
	• Stems have lesions that are up to 5 cm long; the lesions are initially light brown, but become black	Alternaria Stem Blight	pg 101
	• Stem has been chewed off the root	Cutworm damage	pg 90
	• Plants grow poorly despite adequate fertilizer inputs	Possible nematode damage	pg 108
18.	• Leaflets wilting	go to No. 19	
	• Leaflets papery, light brown	Frost damage	pg 117
	• Plants have toppled over	go to No. 20	
	• Leaves are stunted, malformed or puckered	Cold injury	pg 117
19.	• Newly emerged plants die, roots with orange lesions	Rhizoctonia Damping-Off	pg 105
	• Newly emerged plants die, roots are soft, light brown	Pythium Damping-Off	pg 105
20.	• Stem tissue is severely constricted just above the crown	Damping-Off	pg 105
	• The stem has been severed from the root, chewing marks may be visible. Stem and leaves may be pulled into straw	Cutworm damage	pg 90
21.	• Stems have lesions that are up to 5 cm long; the lesions are initially light brown, but become black	Alternaria Stem Blight	pg 101
	• Stems have reddish-brown lesions near the base	Botrytis Stem Blight	pg 103
22.	• Flower petals turn brown and dry up	Botrytis Flower Blight	pg 103
23.	• Green berries turn brown; grey fuzzy mold may be present on mature or immature berries	Botrytis Blight	pg 103
	• Berries turn brown; black fungal growth develops	Alternaria Blight	pg 101
	• Seed head present but seeds do not develop	Heat Stress	pg 117
24.	• Seeds are soft, cheesy inside	Seed Rot	pg 95
	• Seeds are brown/black inside	Seed Rot	pg 95
	• Seeds have protruding orange-red pustules	Seed Rot	pg 95
25.	• Root has rough, raised skin that is rust-coloured; tissue under superficial lesions is normal	Rusty Root	pg 113
	• Root surface is coal-black; interior is white, watery and spongy	Stromatinia Rot	pg 113
	• Roots are beige and rubbery; smaller roots have rotted; the inside becomes soft and can be squeezed out of the root like toothpaste; may have unpleasant odour; dried root has gray-black discoloration	Phytophthora Root Rot	pg 109
	• Roots have small knobs on the finer roots	Root Knot Nematode	pg 108
26.	• The crown has rusty-orange rotted areas, that may include the bud	Rhizoctonia Crown Rot	pg 112
	• Roots have firm, dry, reddish-brown rotted areas that have usually started from the bottom of the root; root can rot away completely; the skin may be all that is left	Rusty Root	pg 113
	• Root surface is coal-black; interior is white, watery and spongy	Stromatinia Rot	pg 113
	• Roots are beige and rubbery; smaller roots have rotted; the inside becomes soft and can be squeezed out of the root like toothpaste; may have unpleasant odour; dried root has gray-black discoloration	Phytophthora Root Rot	pg 109
	• Seed in the soil has failed to germinate	Dormancy Persists Pre-emergence Damping Off Residual Pesticides Seeds dried out No Straw Cover/Cold Injury	pg 105

Table 20 (page 96 – 97) is a disease identification key developed by Dr. Tom Li of Agriculture and Agri-Food Canada at the Summerland Research Station and adapted for use in this guide. There are page number references on the right side of the key that refer to general information throughout this guide.

Occurrence of Ginseng Diseases

The following Table 21, is given to let you assess the probable timing of the diseases that we find on ginseng in British Columbia. It will vary from year to year depending on weather, last season and many other factors. Use it as a guide only.

TABLE 21. Occurrence of diseases and disorders during the growing season and dormant period

Disease/Disorder	May	June	July	Aug.	Sept.	Oct.	Winter
Alternaria leaf spot/ stem blight	X	X	X	X	X		
Alternaria present on old stem debris	X	X	X	X	X	X	X
Botrytis leaf spot/ seed rot		X	X	X	X		
Cold damage/frost	X						X
Cylindrocarpon root rot			X	X	X	X	X
Drought (dry leaf tips)			X	X	O		
Fusarium root rot	X	X	X	X	X	X	X
Interveinal chlorosis (nutrient deficiency)	X	X	X	X	X		
Phytophthora Leaf Blight	0	0	0				
Phytophthora root rot	X	X	X	X	X	X	X
Red leaf spots (mancozeb) on 1 to 2-year olds	X	X	X	X			
Rhizoctonia crown rot/ root rot	X	X	X	X	X	X	
Rhizoctonia/Pythium damping off	X	X					
Root knot nematode	X	X	X	X	X	X	X
Rusty root	X	X	X	X	X	X	X
Sclerotinia root rot			X	X	X	X	X
Slime mold on straw	X	X			X	X	
Sunburn (white patches on leaves)		O	X	X	O		
Wilting — Heat stress/ drought		X	X	X	O		

X = likely to occur at this time
O = may occur at this time

Disease Prediction Systems

There are disease prediction systems available to predict outbreaks of potato late blight, tomato early blight, apple scab, fireblight of pear and other diseases. Data such as temperature, relative humidity, rainfall, levels of disease and periods of leaf wetness are collected with datapods and through visual monitoring. This weather data is fed into a computer program which analyzes the information to predict or forecast disease. Growers can use the disease forecast to determine when a protectant fungicide spray is required. Although no disease prediction system is available for ginseng, it may be possible to adapt the one used for tomato early blight.

Even without a sophisticated computer program, growers can use a rough disease prediction system. For example, we know that the fungi require wet leaves before they can infect. We do not know how long the leaf must be wet before *Alternaria* and *Botrytis* can infect, but it is usually 4 to 5 hours on other crops. Therefore, if the weather has been dry, and irrigation is timed for the early morning, leaves would only be wet for one to two hours. Under these conditions, the fungi will probably not have adequate time to infect leaves, and protectant fungicides are not needed. You also need to know the approximate protection duration of the last pesticide that was applied and what it was applied for. It shows good environmental stewardship to minimize sprays and prevents plant damage, especially on the one- and two-year olds.

Types and Timing of Fungicides

PROTECTANT FUNGICIDES

Timing of sprays is a critical factor in obtaining good disease protection. Protectant fungicides must be applied before wet periods so they present a chemical barrier to spores that land on the leaves. Once a fungicide spray has time to dry onto the leaf, it will not be washed off by rain or irrigation.

Spores require wet conditions to germinate and penetrate into plant tissue. By the time protectant fungicides are applied after rain or irrigation, the fungus is already inside the plant and protected by the epidermis of the plant. It is too late to stop infections with protectant fungicides. Protectant fungicides used in ginseng include Bravo, Dithane, Dyrene and Rovral. Rovral has locally systemic activity which means it is absorbed slightly into the plant tissues that were sprayed. This reduces the chance for the product to be washed off or broken down by microbial activity.

SYSTEMIC FUNGICIDES

Systemic fungicides are taken up and translocated by the plant. Such fungicides persist longer because they are not washed off or broken down by microbial activity. Some have the ability to slow or halt infections within the plant. Ridomil is a systemic fungicide that is absorbed by the roots and moves upwards in the plant. It prevents further growth of the fungus in the plant, although it does not kill the fungus. Getting it to the root zone is a major problem but is important for proper results

Aliette, another fungicide, is also systemic. This product is fully systemic and will translocate to all parts of the plant when sprayed on green portions of the plant.

Tips on Applying Fungicides

- Apply fungicides prior to rain or irrigation so that the fungicide can dry onto the leaves and stems.
- During hot weather, only apply fungicides at night or early in the morning. Do not spray when temperatures exceed 32°C. If you think the foliage will remain wet all night with an evening application it would be better to wait until early on the following morning.
- During cool, cloudy weather, apply fungicides in the morning so that the spray has time to dry during the day.
- See “Pesticide Application Options” on Page 149 for detailed information.

If you have the Ontario Ministry of Agriculture, Food and Rural Affairs Factsheet on “Diseases of Ginseng,” by Dr. R. Reeleder and Pam Fisher, add it into your guide at this point. It is a very good reference on general ginseng diseases with colour pictures plus text.

Please see pages 151 - 164 for specific information on applying and handling fungicides registered for ginseng.

Note: *The label on the container is the legal information and is the final authority.*

Sample Fungicide Control Program

The following is an example of a seasonal program to protect ginseng from Alternaria blight and Botrytis blight. It takes into consideration the maximum allowed number of applications and minimizes the potential for phytotoxicity and the selection of insensitive strains of fungi. **It is a guide only.** Ginseng growers use an average of 9 applications per season, with a minimum of 6 and a maximum of 12 depending on weather conditions and location. Use-management practices are described under each disease section in addition to fungicides for disease control.

1. Quadris — spring year one (seedlings) only
2. Ridomil 2G
3. Bravo
4. Dithane (1/4 - 1/2 strength on 1's and 2's) or Bravo
5. Dithane (1/4 - 1/2 strength on 1's and 2's) or Bravo
6. Aliette @ full plant expansion
7. Rovral
8. Ridomil 2G
9. Aliette
10. Dithane (1/4 - 1/2 strength on 1's and 2's or Bravo
11. Aliette (plants must still be green)
12. Bravo

Note: *Also refer to Syngenta's "Ginseng Production Calendar", available from Syngenta Crop Protection Canada Inc. (see page 167).*

See a sample early season (first 60 days) spray schedule below (Table 21A) for timing of early season disease control.

Refer to Industry Pest Sheets pages 151-164.

Table 21A: SAMPLE GINSENG SPRAY SCHEDULE – FALL/SPRING
(Approx 60 days)
EARLY DISEASE PREVENTION PROGRAM

Chemical Choices	Registered for
Touchdown	Weeds
Dithane	Alternaria
Dyrene	Alternaria
Bravo	Alternaria & Botrytis
Ridomil 2G	Phytophthora & damping off
Aliette	Phytophthora
Metaldehyde	Slugs
Ambush	Cutworms (use only if present)