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American Ginseng Culture in the Arid Climates of British Columbia

Hon. John Savage, Minister
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Introduction

In the fall of 1982 the first commercial planting of American ginseng, *Panax quinquefolium,* was seeded in B.C. This was done after 5 years of research into the crop's cultural requirements by Chai-Na-Ta Ginseng Products Limited. Since that time the B.C. Ministry of Agriculture and Fisheries has been able to observe the crop growing and has obtained first hand information. The purpose of this factsheet is to provide you with the basic information required to grow ginseng to a harvestable stage.

Ginseng is used mainly by people of the S.E. Asian Pacific Rim countries, although it is gaining some popularity in other cultures. The use of ginseng goes back 3000 years or more in China where it is considered the most important herb in their traditional medicine. It is called the "elixir of life" and if taken regularly is said to reduce stress, increase physical stamina, quiet the nerves, enhance blood flow, help in blood sugar and cholesterol levels, help regulate blood pressure, strengthen the metabolism, vitalize body gland functions, slow the degeneration of cells and increase longevity.

The name Panax means a cure-all or all-healing, a panacea, and ginseng (originally jenshen) means man-essence; both names relating to its unique attributes.

Note: The above claims are not recognized by the Canadian Medical Association nor is it a recommendation by the authors.

Ginseng is used in many forms by those who can afford to do so. It is purchased as a whole root, pieces or powdered forms, to name a few and is used in tea, soups, as capsules or may be chewed in small pieces. In China a large percentage of ginseng root is sliced very thin and used in various ways after this. The active ingredients are a group of closely related chemicals called ginsenosides which are produced by and stored in the plant. It is the most widely used medicinal herb in the S.E. Asian Pacific Rim countries. There are two species of ginseng and although both species have many similar qualities they are considered to have differing effects, the N.A. ginseng giving a cooling or depressant effect and the S.E. Asia variety a warming or stimulating effect. Opinions vary but many consider the N.A. variety to be the overall superior variety.

American ginseng was used by most if not all of the native populations in areas where it grew and as well, was traded to other areas for other commodities. It was used for much the same reasons as it was in S.E. Asia.

Wild ginseng, of both species is quite rare and is on a protected species list in most N. American areas and an endangered species in S.E. Asia.

Ginseng production requires a heavy up front monetary commitment, high labor inputs and keen management skills, but can give growers good financial retuns at this point in 1990.

Plant Characteristics

The herb, American ginseng, *Panax guinquefolium,* is a fleshy rooted, herbaceous, perennial, with whorled leaves (see cover diagram). Each leaf of a mature plant has 5 leaflets giving it the latin species name, quinque (five) folius (leaved). It is native to eastern Canada and the U.S.A. from Quebec to Lousiana, Alabama and Arkansas where it grows under the canopy of hardwood forests. It is a shade loving herb and grows naturally only where there

is a minimum of 70% shade. It is part of the Araliaceae (Aralia) family of plants.

From seed the plant produces a single 3 leaflet leaf in the first year. This leaf and aerial stem will be 5 to 10 cm (2-4 inches) high. There is no seed production in the first year. The root will generally be less than 1 gm after the first growing season (fresh weight). Technically the aerial stem that we see is the leaf petiole and the stem is the underground portion on the top of the root from which the yearly bud emerges.

The second year's growth will produce a 15 to 20 cm (6 to 8 inch) plant consisting of 1 aerial stem with 1 or 2 leaves, of 3 or 5 leaflets each. There may be minimal seed production in this growing season.

In its third year the plant will consist of usually 1 stem, 25 to 35 cm (10-14 inches) high, with 2 or 3 leaves on each stem, each generally with 5 leaflets. This growth year will generally see enough seed produced to return to the grower what was initially planted.

The fourth year of growth will produce a 40 to 60 cm (16-24 inch) plant of 1 or more aerial stems, each generally having a whorl of four, 5 leaflet leaves, a typical mature plant. Records indicate that 85% of five year old plants have only one aerial stem. This growing year should produce 3 to 5 times the amount of seed that was used to plant the field. Once a farm is established this can become a fairly important source of income, both as a source of your own seed and seed to sell.

The root may grow in the four years up to 60 grams (approximately 2 oz.) fresh weight, with the average about 14 grams (1/2 oz.), but a wide range in root weights is evident. Planting density may play some part in dividual root weight but not necessarily a fluctuation in a weight per hectare (acre) basis unless a low seeding rate or a germination problem occurred. The roots when dried will be about one-third of the fresh weight or are approximately 30 percent dry matter. The root is a fleshy root similar in texture to a parsnip, often branched, with some smaller rootlets and root hairs. The roots will work their way down into the soil up to 3 inches in a four year period.

Seeds of 3 and 4 year old plants, are produced on a short stalk arising from the leaf whorl and are borne in round clusters of 10 to 50 berries. Each berry contains 1 to 3 seeds depending on the fertilization achieved earlier. The flower cluster, a simple umbel, is self-pollinating but wind and insects will increase the transfer of pollen to the pistil.

We feel bees placed in a ginseng field may enhance the production of seeds and although we do not know this for sure, it cannot do any harm. Bees may work other flowers rather than ginseng if they are available.

This long lived perennial plant gains in value with size, age, quality and shape of the root. The oriental name for ginseng is "Man Root", and roots having a "man shape" have more value.

Ginseng has a zone 3 hardiness rating so will live almost anywhere in B.C. except in the coldest areas. Its shortcomings as a crop is not with hardiness but rather with its susceptibility to diseases, especially in higher rainfall areas.

When we say a tree or plant is hardy in zone 3 that doesn't necessarily mean it is totally immune to damage. Extreme weather conditions can cause problems. Late January 1989 saw the weather over a 10 day period, gradually rise to +16℃ (61°F). Then a cold front came in and the temperature plummeted to as low as −27℃ (−32°F) in about 36 hours. Damage was done to the tops of the roots in some cases but more to the new bud that was to give us the top growth for 1989. Ginseng does not form new buds quickly as some plants will, and three things happened. One, the root formed a new bud and is ready to grow again in 1990. Secondly the bud did not form and the root is still there in the fall and last the root rotted away and only a rotted shell was evidence of a root. The severity of temperature variance would likely determine to what extent each of these would happen. We are suggesting from this that an area that may be zone 3 but gets a lot of temperature variances i.e. chinooks, may not be suitable for growing ginseng.

Another climatic factor that ginseng cannot tolerate is having the root waterlogged. Literature sug-

gests and our experience can support this, that even 24 hours in a saturated condition is enough to do damage. We suggest then that it is imperative that the beds are well formed to allow runoff and the field be sloped to remove excess water from the whole garden.

Ginseng has a dormancy requirement before it will begin to grow properly in the spring, or in a greenhouse. This requirement is about 100 days at a temperature of 0-10℃ or lower. This is not hard to achieve outdoors in B.C. but must be a consideration for other applications.

Quality, shape and color of the root will vary with soil types, climate differences and management, in different areas within the province as well as in N. America. This will vary the prices offered at individual farms, depending on the buyer's preferences.

Ginseng has a very low light requirement and is very easily damaged by high intensity light situations. This is the reason it is always grown under some type of shaded conditions (see the section on Climate Modification).

Site Selection

The intent of this publication is not to discuss all climate areas but rather the arid interior of British Columbia. This is the area we feel has the greatest potential. The reason for this is that we generally have control over the amount of moisture that is applied. When there is a heavy rainfall, our warm dry climate usually dries the soil surface and foliage quite quickly. It is important that the foliage dry quickly, as well as the soil surface, to prevent diseases from starting. Since ginseng is grown under a shade canopy, with a straw mulch, it is apparent that a humid environment can easily be prolonged.

The actual soil type can be quite variable but a humus-rich, well drained loam is best. The site should be free of large rocks since the crop is dug with a potato type harvester. Rocks also may interfere with bed formation.

High soil clay content may cause the soil to remain wet promoting disease problems as well as keeping the soil cooler. High clay soils can also be a problem at harvest time as the crop is in place for 4 years allowing for considerable settling and compaction. This may cause more branching of roots and may also cause lumps of soil to adhere to the roots at harvest. The main concern though of high clay soils, are the disease factors which may occur through excessive water retention.

Sandy-loam soil may not be too much of a problem if a good watering system is in place and moisture levels can be monitored closely. It may though, cause the edges of beds to be rounded or poorly formed.

It is suggested in literature that very sandy soils produce inferior roots that are very long and hard when dried. The plant nutrient levels will also have to be monitored more closely in lighter textured soils.

Good loam soil will have all the advantages needed to grow this crop, good drainage and water retention, easily worked and low compaction as well as other advantages. We are convinced that a great variety of soils can be used but selecting the best available will pay in the end.

Since soil borne fungus diseases thrive on dead and decaying organic materials it might be wise to use land that has been in crop production for some time. This would allow any larger organic objects such as tree roots to be decayed and reduced to humus.

Soil Preparation

Assuming that you have chosen your best location, we will proceed with instructions for soil preparation.

The first and major thing to do, is to assure that the field is free of all perennial weeds such as morning glory, couchgrass, Canada thistle, etc. This can be done with a long term cultivation programme but more likely would be done with an herbicidal spray. Contact your local farm supply store, or the B.C. Ministry of Agriculture and Fisheries office for advice on this topic. Since American ginseng is basically hand weeded after establishment, this is an important first step.

The next step is to work up the soil to a good loose condition, to an even depth of about 20 cm (8 inches). Since you will in all likelihood be forming beds, this is very necessary. If you have hard or shallow place the beds will be uneven and probably not straight, causing problems with post placement in the center of the beds which could interfere with sprayer booms in the future.

We recommend that you do not harvest a crop of alfalfa in the spring and then prepare your land. Let the alfalfa, grass, etc. get up to 8 to 10 inches then spray with a herbicide to kill all foliage. One cutting of a crop like alfalfa could be harvested but a full season of summerfallow would likely prove to be beneficial.

Once the soil is all worked up and your soil amendments and fertilizers are mixed in (see fertilizer section) you need to form the beds. These need to be formed so that they match the dimensions required for the shade cloth. This would mean that the posts would run down the center of every 4th row and the posts would have to be 7.4 meters (24 feet 4 inches) apart. If you were using lath or materials other than the standard 7.3×51.2 metres (24′×168′) shade cloth, these measurements would vary. This woven synthetic shading material is available in other sizes and as long as it is in multiples of 1.8 m (6 feet) widths it can be as long as needed. See Appendix No. 2 for information on sources of shade fabric and supplies.

The beds need to be as wide as possible yet allow room for vehicle wheels to travel, especially the center bed which is the one almost always used for equipment. Generally the beds would be 1.5 metres (5 feet) wide with a 30 cm (12 inch) spacing between each bed. This means that the vehicle and equipment tires need to be quite narrow to reduce the space required between the beds. On the other hand if the space between the beds is too narrow plants will be very close together causing damage to them in spraying operations, etc.

The edges of the beds should be as vertical as the soil will allow, with a slightly rounded center for drainage. At the suggested spacings (see Seeding Depth and Spacing Section), usually 10 or 11 rows are seeded on each bed and if the edges are not formed well, the outside rows will be seeded on the sloped edge.

The field perimeter posts can be placed anytime, but the interior posts should not be put in place until the seeding and mulching is done (See Climate Modifications Section). Once the mulch is on, the posts are installed down the center of each 4th row as mentioned before. We recommend that you use 2.6 meter (8.5 foot) posts, giving adequate clearance to work under when posts are pounded about .6 meters (2 feet) into the soil. These posts should be treated to prevent rot, allowing them to be used in successive gardens. You should also remove the straw in the area where the post is inserted as this may cause the post to be loose when finished. Then you can proceed with the stringing of the cable support systems. See the publication available from Panax Limited in the Materials and Information Sources, Appendix No. 2, for details on construction of the support systems.

Climate Modifications

The natural habitat of American ginseng, is in the hardwood forests of eastern North America. This plant is very sensitive to conditions that vary from this, especially direct sunlight. This means that we need to alter our field conditions to match the native habitat as much as possible.

Since direct sunlight will result in death of the crop, the industry has chosen either wooden lath coverings or the more modern woven synthetic fabrics. The fabric that is generally used filters out 78 percent of the sun. This compares favorably with the natural tree canopy in midsummer. With our high solar irradiances in the arid interior we may be able to reduce this even further and get an acceptable light condition. Shading material up to 90% shade is now available from the suppliers. It seems that there may be higher seed production under 90% shade but no in formation is available as to root yields.

The shading materials must fit quite tightly as spaces left will cause sunscald where the sunlight has appreciable direct contact with leaves. The actual techniques of erection of the woven synthetic

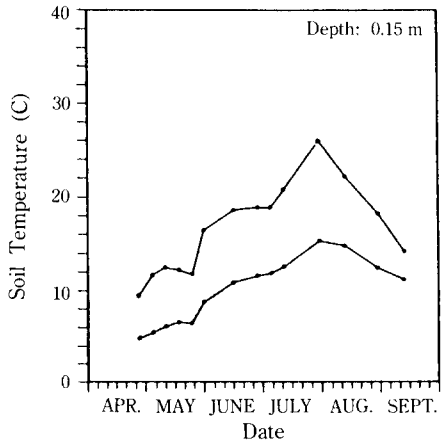

Fig. 1. The trend of soil temperature at a depth of 0.15 m during the 1984 growing season at Lytton, B.C., Canada, in native pasture (upper line) and in a secone-year ginseng garden (lower line). (After Proctor and Bailey, 1987).

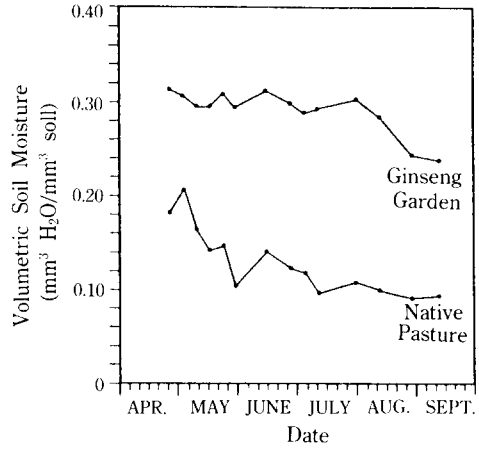

Fig. 2. The trend of volumetric soil moisture for depth 0-0.25 m during the 1984 growing season at Lytton, B.C., Canada, in a native pasture (lower line) and a second-year ginseng garden (upper line). (After Proctor and Bailey, 1987).

shade material is given in a handout available from Panax Limited (Listed in Appendix No. 2).

The wood shade panels are constructed from three 1″×3″×14 foot boards with 1 1/2″×3/8″×48″ lath stapled on with 1 1/4″ staples. Only 12 feet of this length is covered with lath, at various spacings depending on the shade per cent required. This takes approximately 900 panels per acre and is a good project for the winter months. See appendix 7, page 37 for details. These panels sit on top of either 2″×4″, 2″×6″ or steel pipe attached to posts. Posts for this type of shade are put in at a 3.6 m×3.6 m(12′×12′) spacing. This shading requires a different approach to procedures such as spraying, requiring more passes up and down the field per acre. Generally these panels are tied down to stop wind from lifting them off.

Both of these shading materials MUST be removed or winterized (see information from Panax Ltd.) and not be spread out again in the spring until danger of snow is past, to prevent damage due to snowload. The shading materials and structures must be able, as much as possible, to withstand the worst storms that may occur in the area. These include hail storms, high winds and similar events.

There are advantages to either the wood lath or the shade cloth as follows:

Wood
- more air circulation
- cover irregular land areas
- use more of the field as no exterior wire support are needed
- more seed production
- better looking plants-if that is important

Woven Cloth
- cheaper to erect
- as good or slightly higher root yield
- easier to maintain
- less equipment travel and plant damage

The other major climate modification is mulching which is done to simulate leaves and leaf mold on the forest floor. In most situations, straw is used, applying a 5 to 7.5 cm (2-3 inch) layer evenly over the beds after seeding. The type of straw (wheat, oats, barley) doesn't seem to matter although the preference in the industry as a whole is oat straw. It seems that oat straw is coarser and doesn't pack as tightly over winter allowing easier emergence of the plants in the spring. Care should be taken to purchase mulches that are as clean as possible to eliminate weed seeds and since this crop is virtually all hand weeded, this is an important factor. DO NOT get materials such as fall rye or winter wheat as any fall germinating seeds will not die over winter, resulting in a weed problem the following year. Because of our dry climate, one applica-

tion of straw, after seeding, should be all that is required for the four year duration. You may wish to apply a 1 to 2 inch layer of straw the first fall and another layer the second fall of 1 to 2 inches. This allows the first year seedlings easier emergence.

These two climate modifications, shade and mulch, affect considerably the soil temperature and the volumetric soil moisture. See Figures 1 and 2, derived from work done by Dr. W.G. Bailey. This is currently in press in an article "Ginseng: Industry, Botany and Culture" in the Horticultural Reviews, by Proctor, J.T.A. and Bailey, W.G., 1987.

The mulch can be applied by hand but on a large scale, a motor or P.T.O. driven chopperspreader is a must. Many variations of these are used and most are custom made. See Appendix No. 2 for a list of possible equipment sources.

The use of raised beds is a soil climate modification and is covered in the section on soil preparation. This will give better root zone drainage in times of heavier precipitation. Bed formmers are available or can be custom made. See Appendix No. 2 for possible equipment suppliers.

Varieties and Seed Sources

There are other species of ginseng, but there are only two that are of commercial importance. The species *Panax ginseng*, (Chinese, Korean or Oriental ginseng) is native to northeastern China and Korea. The species we grow in North America American ginseng, *Panax quinquefolium* and is native to a large part of eastern U.S.A. and Canada. To date, there are to our knowledge, no American ginseng cultivars selected as being superior with respect to vigor, resistance to disease, etc. This poses a challenge for plant breeders or even commercial growers, to select superior strains from existing fields.

There are few seed sources available currently in B.C. (see Appendix No. 2). The traditional seed source up to now has been from Wisconsin, U.S.A., from companies on this same listing. The Ontario seed market is also becoming available to us in B.C. as our industry grows.

Another product, called Siberian ginseng is the plant *Eleutherococcus senticosus* and is reported to produce similar chemicals and give similar results. This plant is not ginseng but is related to ginseng and is sometimes sold as ginseng. Do not confuse this with genuine ginseng products.

Stratification of Seed

Seed is produced on 3 year and older plants and is harvested by hand between late August and early October depending on ripening. It is picked when the berries are crimson red. The berries do not ripen all at the same time, but can be harvested at one time. There may be some loss from older berries dropping off, but not sufficient to warrant two pickings. The ratio of ripe berries to clean seed is about 4.5 : 1, thus 45 pounds of red berries yield 10 pounds of seed.

Generally when seed is purchased it is previously stratified ready to mix with fungicide and sow. If you purchase "green" (current year's production) seed with the pulp removed, you will have to follow the procedures starting at point 4. below. The reason ginseng seed needs to be stratified is that it has an immature embryo which has to develop before germination can take place. This process takes 18 to 22 months under the following controlled conditions.

The suggested basic steps of seed stratification are as follows:

1. Pick berries when ripe (crimson red), place in jute sacks, tie securely.

2. Lay these sacks preferably on a wood or cement floor in an unheated building. Keep them moist with water for 5 to 10 days. Turn and knead these bags by walking on them 2 times per day to assure all berries are being fermented evenly.

3. Remove from bags and wash off the pulp, which deteriorates and separates from the seeds, by placing in a box with a 1/8 inch mesh screen bottom and spraying with water.

4. Soak the depulped seed in a 1 percent formaldehyde solution for 20 minutes and let them surface dry before proceeding to the next step. DO NOT let the seed itself dry out.

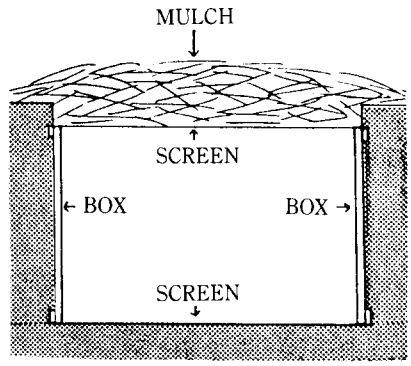

Fig. 3. A diagram showing the suggested placement of seed for the outdoor stratification process

5. Mix with a suitable fungicide, such as thiram, thiram plus carbathiin or captan using ONLY enough to lightly coat the seed. We suggest that 30 gm per 12 kg (1 oz/25 lbs) of a 50 WP product should be adequate. DO NOT use Ridomil as a seed treatment.

6. Mix with equal parts of sand, no coarser than half the size of the seed for ease of separation at a later time. Put 4 inches of plain sand in the bottom of the box for drainage and 4 inches on top of the box to protect the seed from drying out. USE CLEAN SAND with no soil particles in it. Purchase washed sand from a cement company, if a reliable source is not available locally.

7. Place outdoors overwinter in a wooden frame with top and bottom screened. This allows moisture and air to move freely and keeps out rodents. This frame is buried to ground level, with a straw mulch over the top to stop surface evaporation (see Figure 3).

8. The following spring, remove the box and separate the seeds from the sand by screening and float off all non-viable seeds in water.

9. Soak again in a 1 percent formaldehyde solution for 20 minutes and let surface dry. Repeat treatment as in 5 above. Mix with sand again and place outdoors in box as in step 7 above until seeding time. Place this under a shade canopy to reduce direct heat on the area keeping it somewhat cooler.

10. Check periodically to see what the moisture content is. It must not be allowed to dry, so water as necessary.

11. At seeding time (September) remove seed, separate from sand, float off all non-viable seeds in water and let seed surface dry. The seed can be soaked again in a solution of NOT MORE than 1% formaldehyde for 20 minutes, or mix with a fungicide such as thiram, thiram and carbathiin or captan and sow the seed. DO NOT use ridomil as a seed treatment.

Seeding Depth and Spacing

Once everything is prepared for seeding, there are various ways to seed, depending on the size of the field. The most obvious is by hand distribution. The next method is a hand operated single row mechanical seeder. The Planet Jr. seeders seem to be the most popular and are very reliable as far as seed spacing in the row. With a Planet Jr. setting of 27 to 32 will normally give the suggested average density of 100 pounds per acre. The planter would have to be checked and adjusted for the density required. The industry seeds anywhere from 85 to 135 pounds per acre. Seed should give you at least 70% germination with many seed lots achieving 85% or more. Since stratification is necessary and complicated, germination tests are difficult to do. It depends on the operators precision for the spacing of the rows in the bed.

Seed Trivia

1 pound of stratified seed = 7 − 8000 seeds
1 imperial gallon of stratified seed = approximately 62,500 seeds
100 pounds per acre = 700 − 800,000 seeds per acre
At $ 100.00 per pound, seeds cost about 1.3 cents each

The method for large plantings, is a gang of seeders as a single unit, pulled by a tractor. The ultimate and most time efficient is to have all the rows seeded in one pass. We are not aware of anyone selling the complete unit for larger fields so it would have to be custom built.

The actual seeding depth is about 1.3 to 2.5 cm (1/2 to 1 inch). The seeds are approximately 6 mm (1/4 inch) long, kidney shaped and 3 mm (1/8 inch) thick. They are seeded about every 5 cm (2 inches) in the row, with rows approximately 12 cm (5 inches) apart. At this spacing it takes about 112 kg/ha (100 pounds per acre) to seed the field, giving a plant density of about 150 per square meter (125 per square yard).

When you purchase seed you must not let it dry out before or after it is seeded. Purchased seed for fall sowing should be previously stratified (and you must know this) and only needs to be treated with a fungicide and sown. You should programme delivery data with seeding time, so there are no delays. If there is wet weather and you cannot seed immediately, seed will store a considerable time in proper containers in a cool, moist place. Literature suggests that placing seed in a refrigerator at this point has delayed germination for an extra year. The reason is not known.

Once the seed is in the ground it must not be allowed to dry out. It should be covered immediately with straw and then make sure that if the fall is warm and dry that it is irrigated as needed.

Soil Testing and Fertilization For Ginseng

Because the selection and treatment of soil is a most important area for overall success, we have given this section a fairly large part of this pamphlet.

Before buying land or making any preparations for establishing ginseng, it is important to determine whether a soil has the desirable combination of chemical properties for growing this crop. A soil test interpretation will indicate which fertilizer or amendment additions are required to ensure adequate nutrient reserves and provide the optimum root environment for crop growth. Each ginseng garden should be sampled yearly using the procedure outlined in the leaflet entitled "Soil Sampling" available free on request from your district agriculture office.

Manure, if available can be incorporated into the soil in the preparation year. Amounts up to 40 tons per acre have been used. A soil sample, just prior to bed preparation, would then be necessary to see what additional nutrients were needed, that the manure did not supply.

It is efficient and economical to adjust soil fertility before seeding and maintain it with annual additions, as indicated by the recommendations on your soil test report. Remember, phosphorus, limestone, copper and zinc are very immobile in the soil; potassium and magnesium are moderately mobile; and nitrogen, boron and sulphate can be quit mobile. Incorporation of the immobile and moderately mobile plant nutrients in the root zone before seeding (when the soil can still be worked with a rotovator for example) is particularly important as the crop may otherwise experience nutritional deficiencies because added fertilizers have remained near the soil surface and consequently may not be accessible to plants.

Soil Organic Matter (OM)

Organic matter, also called humus at times, is an important indicator of soil quality. The soil level should probably be above 2% but below 8%. Levels that are near 8% or higher suggest that the soil may not be (or was not) well drained. Organic matter influences not only the supply of plant nutrients in a soil but also its structure. For example looking at opposite ends of the scale, the heavy textured soils (clays, silts, silty clays), are at one end and at the other end, very light textured (sandy) soils. Heavy textured soils retain too much water; light textured soils not enough moisture and plant nutrients. Organic matter improves the drainage of heavy textured soils and allows air to move more readily through the soil, warming it up earlier in spring. Organic matter additions to sandy soils improve its moisture and plant nutrient holding capacity. Although it is possible to improve soil by adding organic matter, it may be more economical to select a soil that has good level.

Soil pH

American ginseng grows naturally in acid forest

soils with relatively high rainfall. These usually have pH values situated between 4.8 and 6.0. In British Columbia a much wider natural variation in soil pH is observed than is optimum for growing ginseng. Values commonly range from about 4.5 to 9.0. The more acid soils (lower pH) are generally lower in fertility. Plant nutrients have been leached over the years from the root zone of these soils. Furthermore, acid soils may contain plant-toxic levels of aluminum and/or manganese. Potential toxicity of these elements to plants can easily be controlled by keeping soils at pH 5.5 or slightly higher. Soil pH values above 7.8 should probably be avoided as ginseng may have difficulties absorbing adequate amounts of micro-nutrients for optimum growth. The availability of many micro-nutrients is reduced with increasing pH values. This crop can probably be best grown at a soil pH situated between 5.5 and 7.5.

Salt

The electrical conductivity (E.C.), or salt level, of a soil is a measure of the amount of salts in the soil solution. In its natural habitat of high rainfall and low soil fertility (acid soils), ginseng is rarely exposed to significant salt concentrations. It therefore would have little need to have a natural tolerance. Accordingly, it is suggested that the conductivity level of a soil should be below 1.0 dS/m (deci-Siemens per meter=millimho per centimeter) as determined by a soils lab testing. Higher salt levels frequently occur in British Columbia, particularly in the arid and semi-arid interior. The cause of salt accumulation is a rainfall deficit: i.e., an insufficient precipitation relative to evapotanspiration. More abundant precipitation would leach (move) soluble salts to below the root zone. Salt levels are quite variable in a field and tend to accumulate in seepage areas. Over-fertilization may also cause excessively high salt levels. Some of the accumulated salts may be plant nutrients. Generally, significant salt levels in the soil solution reduce water availability to plants. An excessive salt level will usually show its effect on hot days when crop water requirements are highest. Excessively high salt levels will reduce and may inhibit crop growth. The salt level in a soil can be reduced by applying more water than required by plants; however, in practice it may be difficult to reduce soil salinity to the recommended value in a short period of time if the value is much above the recommended value. We also need to watch the water saturation of some soils, causing root rot problems to occur.

Nitrate-N

Nitrate is the preperred and most readily availabe form of nitrogen for plants. This soil test reveals its concentration in soils expressed in μg/mL (microgramms per milliliter soil which is approximately equal to parts per million; ppm). The test value is used to calculate the recommended nitrogen fertilization rate by subtracting the readily available nitrogen reserve in the soil from a maximum recommended rate which would be applied when no reserves are present.

Maximum nitrogen rates increase with the age of gardens. These are 40, 50, 60 and 80 kg N/ha for 1, 2, 3 and 4 year-old gardens, respectively. It is important to monitor soil nitrate levels at least yearly. Fertilization should preferably be carried out during the dormant season at least a couple of weeks before plants emerge to avoid fertilizer burn of plants. Although plants generally prefer nitrate nitrogen over other forms, some ammonium will be absorbed. In any event, ammonium fertilizers are usually quickly converted to nitrate in soils by soil microbes.

Nitrogen is a major plant nutrient; it is usually absorbed by the crop in greatest quantity. The effects of optimum levels in soils are marked; when adequately supplied for rapid growth, it imparts to plants a deep green, healthy colour. The most apparent effect of adequate nitrogen fertilization is the encouragemment of above ground vegetative growth. On the other hand, literature suggests that excessive nitrogen may cause overly lush tops resulting in more disease problems annd possibly a reduction in root yield. If available nitrogen begins to fall short of the crop's needs, the remaining nitrogen is used by the new shoots; a severe deficie-

ncy may cause plants to mobilize nitrogen from the older to the new growth. This phenommenon causes the characteristic general yellowing of mature leaves when nitrogen is deficient.

Phosphorus

Plant available soil phosphorus levels are expressed in μg P/m*l* soil (micrograms per milliliter). The soil test value is accompanied by a rating index (VL=very low; L=low:; H=high, VH=very high). Consult Leaflet#1, entitled "How to Use Your Soil Test Report" available free from a Ministry of Agriculture and Fisheries office. Table 1, page 11 shows the relationship between the amounts of recommended plant nutrients on the soil test report (N, P, K) and the amount of fertilizer required to meet the recommenndation.

Phosphorus is relatively immobile in soils. It is, therefore, particularly important that soils be tested and fertilized before seeding so that the fertilizer can be incorporated into the soil layer where roots are going to proliferate. Fertilization before seeding can ensure an adequate phosphorus supply for the duration of the garden. Should a low phosphorus level be discovered in an established garden, surface applications may be utilized, depending on how deficiennt it is, though such applications are generally quite inefficient.

Phosphorus is the second important macronutrient and an adequate supply is essential in all phases of plant growth. It is important for the effective formation of above and below ground parts of plants as well as to ensure disease resistance. If the phosphorus supply is inadequate to meet the plant's needs, the existing phosphorus, like nitrogen, will move from the older to the younger tissues. Accordingly, visible signs of a deficienncy, when they appear, show on the lower leaves. The symptoms may be a lack of chlorophyll, a deepening of the green color, or a reddish-purple color on the lower leaves.

Potassium

This is the third major plant nutrient (macronutrient). Potassium (K) is essential for growth and is absorbed by plannts in very large quantities, more than any other nuutrient except nitrogen. Plant-available potassium measured by a soil testing laboratory represents essentially the exchangeable portion of the total potassium in the soil. Of the total potassium in soils only about 2% or so is plant available, the remaining is held as part of soil minerals. Soil test levels are expressed in μg K/m*l* soil (micrograms per milliliter). The soil test value is accompanied by a rating index (VL=very low; L=low; H=high; VH=very high). Consult Leaflet #1, entitled "How to Use Your Soil Test Report" available free from a Ministry of Agriculture and Fisheries office. Table 1, page 11 shows the relationship between the amount of recommended plant nutrients on the soil test report (N, P, K) and the amount of fertilizer required to meet the recommendation.

Many soils in British Columbia are well supplied with potassium and generally if the soil test shows that it contains 250 μg K/m*l* soil or more, the soil can be considered to have an ample reserve to meet crop growth. Heavier textured soils are generally well supplied with potassium; sandy soils often have a deficiency. This plant nutrient is moderately mobile in soils and surface applied fertilizers can generally be brought down to the root zone within the growing season. Nonetheless, it is important to make any major applications before seeding when it can be readily incorporated in the rooting zone along with other fertilizers. Subsequently, an adequate supply can be maintained by adding only minor ammounts during the dormant season.

Calcium

This is usually the most abundant plant nutrient in soils. It is largely held on the soil cation exchange complex when soil pH is lower than about 6.5. Levels are increased in soils by liming; a good quality limestone will contain up to 40% calcium. However, except for rare exceptions, calcium does not need to be added to soils to meet crop needs when the pH is in the desirable range. Soils are generally well supplied for meeting plant needs. On soils co-

Table 1. Relationship between the amounts of phosphorus and potassium extracted from soils with the Kelowna extractant and the soil test ratings, fertilizer recommendations and comments.

PHOSPHOROUS				POTASSIUM			
Soil Test P μg/ml	Rating	Phosphate Rec.	Coments*	Soil test K μg/ml	Rating	Potash Rec	Comments*
5	VL	200	PG	50	VL	400	KG
10	L−	170	PG	65	L−	350	KG
15	L	140	PG	80	L	300	KG
20	L+	100	PG	100	L+	300	KG
25	M−	80	PG	125	M−	250	KG
30	M	60	PG	150	M	200	KG
40	M+	50	PG	175	M+	150	KG
50	H−	40	P2	190	H−	100	KG
75	H	40	P2	220	H	50	KG2
100	H+	40	P2	250	H+	50	KG2
999···	VH	0	P3	999···	VH	0	K3

*COMMENTS

PG −Broadcast and incorporate the recommended phosphate rate into the root zone before seeding

P2 −Soil is well supplied with this nutrient, the phosphate rate is intended for maintaining soil fertility

P3 −No application of phosphate is recommended as the soil already contains an abundant supply

KG −Broadcast and incorporate the recommended potash rate into the root zone before seeding. If the crop is established potash can be applied during the dormant period, in some instances the rate may be reduced. Consult your horticulturist.

KG2 −Soil is well supplied with this nutrent, the recommended potash rate is intended for maintaining soil fertility.

K3 −No application of this nutrient is recommended as the soil already contains an abundat supply

ntaining appreciable sodium, calcium is often added to aid in improving or stabilizing soil structure. However, high sodium soils should probably be avoided for growing ginseng.

Plant roots and tips do not elongate in the absence of calcium. The element is related to protein synthesis, enhanced nitrate uptake, enzymatic activity, and is an important constituent in the building of cell walls. This element is considered immobile in herbaceous plants. However it is very rarely deficient.

Magnesium

Unlike calcium, magnesium is quite often deficient in soils. Deficiencies occur most often on coarse textured and acid soils. Like calcium, plant available magnesium is held on the soil cation exchange complex if soil pH is below about 6.5. A fertilization recommendation appears on the soil test report when the concentration is below 100 μg Mg/ml soil. Recommendations are expressed in kilograms magnesium (mg) per hectare. Consult leaflet # 1 entitled "How to Use Your Soil Test Report" for additional information on how to calculate the rate of fertilizer required per unit area of land.

Magnesium is absorbed by plants as an ion (Mg^{2+}). It is the only mineral constituent of the chlorophyll molecule and is located at its center. The importance of magnesium is obvious for without chlorophyll no photosynthesis would be possible. This element is also used in plants for phosphorus metabolism and is considered specific in the activation of a number of plant enzymes. Magnesium is mobile in plants and is readily transferred from older to newer tissues. Consequently, deficiency symptomos often appear on lower leaves. In many species the deficiency results in interveinal chlorosis of the leaf, where only the veins of the leaf remain green. In more advanced cases, leaves be-

come uniformly yellow, and as the deficiency aggravates, leaves start to curl, brown and eventually die at the margins. If the latter symptoms appear by themselves without chlorosis, then the problem may be caused by other factors such as excessive salts or disease.

Sodium

Sodium is not considered as a plant nutrient, though it can substitute for potassium in some crops, notably sugar beets. Nonetheless it is one element that is desirable to have as little of as possible in soils. Levels below about 100 μg/m*l* can generally be considered as negligible, and this level is desirable. Sodium is important mainly because of its negative effect on soil structure. However, sodium concentrations should not only be considered alone, but also its relationship to the quantity of soil structure improving cations, like calcium.

Sulphur

Sulphur levels are generally determined routinely on all soil samples submmitted to a soil laboratory. Analytical results are expressed in μg S/m*l* soil (micrograms per milliliter). A sulphur fertilization recommendation should appear on the soil test report when soil test levels are 25 μg or lower. Sulphur deficiencies are quite common in British Columbia, in the Prairie Provinces, and Western United States; unlike Eastern Canada or the Eastern United States where relatively larger amounts of sulphur are added to soils through acid rain. Sulphur fertilization is particularly important because a deficiency can have severe repercussions on crop yield (like other plant nutrients), and because ensuring its adequacy can be achieved at little or no cost by using appropriate fertilizers.

Like nitrogen much of the sulphur present in plants is reduced to different chemical forms; however, sulphate can be present in cell sap in quite large concentrations without any apparent harm. Sulphur is generally present in plants in comparable concentrations as phosphorus. A sulphur deficiency has a retarding effect on plant growth, it is characterized by uniformly chlorotic plants--stunted, thin stemmed, and spindly. These symptoms resemble those of a nitrogen dificiency and diagnosis of deficiencies of these elements are often confused. However, unlike nitrogen, sulphur does not appear to be easily translocated from older to younger plant parts when deficient. Sulphur is required for the synthesis of amino acids, proteins, and vitamins, it activates enzymes, and influences cold resistance in crops. When sulphur is limiting, nitrate-nitrogen often accumulates in plant tissues instead of being synthesized into proteins.

Boron

Boron is an essential micro-nutriennt which is often deficient in British Columbia soils. Boron determination is an optional test and should be requested when submitting samples for testing. Analytical results are expressed in μg B/m*l* (micrograms per mmilliliter; parts per million, ppm). When test levels are 0.5 μg B/m*l* or lower, a fertilizer recommendation is generally provided by a soils laboratory. Ginseng is not considered as a high boron requiring crop, but because soils are frequently poorly supplied with this micro-nutrient it is important that its adequancy be verified. Cost for maintaining adequate levels are usually quite low; however, considerable difficulties may be encountered in applying the low levels required. The recommended rates vary from 1 to 2 kg B/ha (kilogram elemental boron per hectare).

Great care should be exercised in applying boron at the recommended rates (do not double or triple rates without consultation), as boron can quickly become toxic to plants at relatively low levels. It is suggested that the concentration of this element be verified regularly (yearly) in soils. Probably the simplest procedure for applying boron accurately is to use a soluble boron compound (i.e., SOLUBOR) in a calibrated sprayer and spray the recommended rate on the soil during the dormant period. Consult leaflet # 1, entitled "How to Use Your Soil Test Report" available from a Ministry of Agriculture and Fisheries office for details on boron compounds and procedures for determining required

rates.

Boron can also be absorbed through the leaf and small foliar applications can be made to alleviate a deficiency. Several applications during the growing season may be required in such cases as boron is not translocated from older to meristematic (new) plant tissues. The tolerance of the crop to foliar applications is not known, consult your district horticulturist for a suggested rate that has been used successfully with other crops.

Boron, like nitrate is quite mobile in soils. Shortages are more common on coarse textured soils. Soil moisture also influences availability. Therefore dificiencies may appear during droughty periods on soils that are marginally supplied.

Boron is needed for cell division in actively growing plants and has an important role in carbohydrate metabolism. Boron is involved in the uptake of calcium by roots and its efficient use in plants. Symptoms in several root crops are shown by the breakdown of internal root tissues giving rise to darkened areas often described as brown or blackheart.

Zinc

Zinc and boron are the most commonly deficient micro-nutrients in British Columbia. Like boron, zinc can be absorbed through the leaf and is toxic in anything but minute amounts. Experience in British Columbia suggests that ginseng cannot extract zinc efficiently from soils; particularly if soil pH is 6.5 or higher. Zinc is relatively immobile in soils and its adequacy should be ensured before planting when the application can still be worked thoroughly into the root zone.

Soils are not routinely tested for this element in British Columbia.

Deficiency symptoms vary with the crop and the severity of the deficiency; however, on many crops it appears as bleached tissue occurring on each side of the midrib. Deficiency symptoms can often be aggravated with phosphorus fertilization. Zinc is used in the functional component of many plant enzymes and for the regulation of crop phosphorus nutrition. Should deficiency symptoms be observed or suspected, this element can also be foliarly applied. In such cases several applications need to be made during the growing season, though zinc can probably be applied in combination with some other crop sprays. Zinc sprays are used extensively in orchards and zinc is an active ingredient in many fungicides.

Our knowledge of ginseng fertilization and fertility management is evolving, and every effort is made to reflect current knowledge in the recommendations appearing on our soil test report. Fertilization is only a minor cost in ginseng production, its importance in successful crop production, however, cannot be over emphasized. Adequate levels of plant nutrients and appropriate soil fertility parameters help ensure a profitable industry. In conclusion, let us provide you with good advice "Soil Test--Don't Guess" and discuss fertility management with your district horticulturist.

If you wish to have more detail with regards to soil tests, nutrients, etc., we can provide more information from our Ministry of Agriculture and Fisheries district offices. There are also soil laboratories that can be contacted with regards to soil testing and nutrient recommendations (see following list).

Griffin Laboratories Corporation
Soil, Feed, and Tissue Testing Laboratory
1875 Spall Road
Kelowna, B.C.
V1Y 4R2

Telephone; 861-3234

Norwest Soil Research Inc.
203-2071 Langley Bypass
Langley, B.C.
V3A 5E8

Telephone: 530-4334

Pacific Soil Analysis Inc.
No. 5-11720 Voyageur Way
Richmond, B.C.
V6X 3G9

Telephone: 273-8226

Water Quality

The average soil salinity of the root zone is closely related to the quantity and quality of irrigation water. Irrigation water quality is important, because as plants remove moisture from the soil, the salts in the soil water become more concentrated as salts largely remain in the soil solution. Waters with an electrical conductivity (EC) of less than 0.75 dS/m (dS/m=deci Siemens per meter=millimho per centimeter) usually present no problems. Those with an EC ranging between 0.75 and 3.0 dS/m increase possible problems significantly. Water with conductivities greater than 3 dS/m present severe problems. In addition to water conductivity, its sodium absorption ratio (SAR) value should be considered in evaluating its quality for irrigation. SAR values should be significantly below 10.

The Griffin and Northwest labs listed above in the soils sections also do irrigation water quality analysis. This will provide required information concerning the concentration of salts in solution and some possible toxic elements that could accumulate in soils.

Water Requirements

Ginseng is an interesting crop in that it is a low user of water. This is partly due to the plant itself and secondly because of the modified environment.

You still may need to irrigate 1 to 6 times or more per season, so water must be available. Generally it is applied with an overhead sprinkler system either from above or below the shade material. A solid set system would be most practical but a hand move is probaly least expensive.

Ginseng foliage grows for a short period in the spring, from early May to early July, at which time a full leaf canopy is developed. The only visible development after this is seed production. The plant does photosynthesize during this period, when the seeds are produced and the root increases in size. This growth pattern does not require much water in the hot summer. When this crop is grown under a shade canopy and with the mulch over the soil, evaporation is reduced considerably.

You want to watch how early and how much you water early in the season, when evaporation and plant requirements are low, to reduce the potential for root disease. You need to watch this carefully all season as there will be a tendency to overwater during hot, dry periods.

Soil must be kept adequately moist in the root zone. Without a moisture meter or other mechanical or electrical devices that are available, you will need to develop techniques to assess this. If you take soil and squeeze it in your hand and it stay in a ball when bounced a bit in your hand, there should be adequate water. If it falls spart then you may need to water. Sandier soils will not hold together as well and soils high in clay content will hold together with less water so some adjustment for soil types will be necessary.

If possible you should water in the early morning so the crop has adequate time to dry before mid-day heat. You also want to assure that plants are not wet going into the evening, reducing the potential for fungal diseases. Watering in mid-day on a very hot day could cause some leaf burn on new, more sensitive leaves.

Weeds

One of the first things you need to be aware of is that there are no herbicides registered for use on ginseng. This is true with insecticides as well.

As mentioned in the Soil Preparation section, perennial weeds need to be controlled before seeding. Annual weeds are hand weeded and must be done when they are small, so that you do not disturb the ginseng roots when pulling the weeds. This may necessitate 3 to 4 passes over the field per season. There is work being done on herbicides and we may have some minor use registrations in the near future.

Because of hand weeding, a labor force must be in place. This may be easy to find for a small field but can you get a labor force to hand weed a larger field? This is also true for harvest time.

This crop is also a host to the parasitic weed, dodder. We suggest because of this that you be

cautious when selecting sites. This weed is very hard to hand weed as it winds around the stem, as well as attaching itself to the host plant with root-like appendages. If left alone it could eventually kill many ginseng plants.

Keep in mind that there is NO mechanical weed control once the crop is seeded. This is a consequence of the mulch used on the beds and the closeness of the rows.

Insects

To date, any ginseng field that has been grown in B.C. is essentially insect free. This is not to say this will continue as in all likelihood we will have some problems somewhere, sometime. Insects such as aphids, thrips, mites, etc. have very many host plants and have the potential to cause problems.

In the literature that we have read, the only four insects mentioned as problems are the longtailed mealy bug. hemispherical scale, cutworms and oyster shell scale. There was no mention of the extent of these pests.

Slugs and snails have been a problem in Ontario, but this will not likely be much of a concern in our dry climate, although some slugs are found from time to time.

Cutworms have been a slight problem in one field, but so far have not been an economic problem. An indication of this pest will be a young 1 or 2 year old plant that is wilting and falling over that is not attached to the root. In other words it is cut off, generally at ground level.

Nematodes

These are small microscopic wormlike animals that live and move in the soil. Since ginseng is a crop that stays in the ground for several years it is an ideal target for nematodes. The root lesion nematode *Pratylenchus penetrans* is found in many parts of B.C., so it might be wise to have a soil sample done for this pest. If the economic threshold of 100 nematodes per 100 m*l* soil is exceeded a lab might recommend that you fumigate before you seed the crop. Nothing can be done after ginseng plants are in the ground.

Root knot nematodes could possible be a problem in some areas, but not likely. They are listed in the publication "Diseases of Cultivated Ginseng" from the University of Wisconsin.

Nematodes can be tested for in B.C. at:

Quantum Nemalab
530 Short Road, R.R. #5
Abbotsford, B.C.
V2S 4N5
Telepheone: 852-2147

The application of fumigation materials can be done by yourself using equipment supplied from a chemical company or by companies that do custom fumigation (See Appendix No. 2).

Animal Damage

This is an area where there are few problems. In the literature there is mention of root feeding by some rodents but to date we have observed no damage. If you are in an area inhabited by pocket gophers it might be wise to eliminate these before planting and keep control of them around the garden.

One concern we have is the presence of snakes in the mulch and plant canopy. The shade cloth and mulch probably gives them needed protection 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.

It also appears that deer and bear are not a problem with either the foliage or the roots.

There has been one instance of a garden near an area where a high pheasent population exists, where the birds wandered through and ate or snapped off the tops of some first year plants. This was controlled by using some light chicken wire around the garden but was a nuisance to remove for spraying.

On another occasion wild turkeys came into a garden and scratched around doing some damage. Not many areas in B.C. have this bird species so not much concern exists.

There have been some instances where mice have been prevalent in an area and have moved into a field after seeding and straw spreading. All you can do is watch for this and protect with rodent bait as necessary. Most growers use some protection as a precaution.

It would be wise to continue checking for all animal life that may develop a taste for this crop, e.g. birds or squirrels eating the berries.

Diseases

Damping-Off Disease

-Primarily a disease of seeds and young seedlings.

Caused by: *Fusarium spp.*
Rhizoctonia solani
Pythium spp.
Phytophthora spp.

Where does damping-off occur?

Damping-off is the most common disease that has been identified in B.C. ginseng gardens. Bare patches scattered throughout a ginseng garden or in lower, wetter spots are glaring evidence of damping-off damage. Many beneficial micro-organisms such as fungi naturally inhabit the soil. Deleterious fungi, *Fusarium spp.* and Rhizoctonia solani, are common soil inhabiters responsible for damping-off in B.C. ginseng. *R. solani* damping-off, a major problem in Wisconsin ginseng crops, has been identified in B.C. ginseng gardens.

What is damping-off of ginseng?

Damping-off can be a very serious disease of ginseng seeds and young seedlings early in the growing season. In the early stages of germination seeds infected by damping-off fail to sprout. Other seedlings may be killed beford they emerge (pre-emergence damping-off). Young seedlings may topple over and die juist after they emerge (post-emergence damping-off) Stems at the soil line are generally water-soaked, shrivelled and discolored. Seedlings quickly wither and die. Prolonged cool, wet weather provides ideal conditions for damping-off to thrive. With the onset of warmer, drier weather, damping-off ceases. Bare patches throughout the garden are evidence of damping-off. Yields can be drastically reduced. Some plants may survive damping-off infection but the roots remain poorly developed.

How does the disease survive overwinter and infect ginseng plants?

Damping-off fungi have resilient resting propagules that allow for their survival many years in the soil. Patches of damping-off are spread by water runoff or equipment that is used in the planting. Low temperatures in the winter cause the fungi to become dormant until the spring when ginseng starts to grow. Prolonged cool, wet conditions, enhanced by the shade cloth and mulch, offer ideal conditions for damping-off. Germination seeds and young seedlings are the most susceptible to damping-off. The disease will slow down with the onset of warm, drier weather. If left unchecked root rot can develop later in the season.

Conditions favoring damping-off

Growing conditions in a ginseng garden are very favorable to damping-off . Management practices can increase the disease severity.

Heavy soils and low, wet sites are high hazard areas for damping-off outbreaks. Prolonged cool, wet conditions promote the problem.

Excessive seeding rates leads to overcrowding, poor air circulation and plant stress. Damping-off is easily transmitted by the close root contact.

Thick straw mulching keeps the soil cool and moist and also favors damping-off. The mulch as an effective barrier to any pesticidal sprays that are applied.

Improved drainage is a major benefit when growing ginseng in raised beds. The risk of damping-off is reduced when raised beds are used.

Rhizoctonia solani damping-off and root rot is a concern on sites where alfalfa was previously grown. Preparing and leaving the site fallow for a year preceding planting is one way to avoid potential carry-over problems.

Good soil fertility and pH 5.5-7.5 is important in growing healthy ginseng plants which are more

resistant to diseases. Excessive chemical fertilizer or manure, forces lush foliar growth and can make the plant more susceptible to disease.

Extensive areas under shade cloth restricts air movement causing dead air spaces in the center of a ginseng garden. With the increase in temperature and humidity in these spots, disease outbreaks are more likely to occur. A method of opening and venting the shade cloth is advisable.

Optimal soil temperature for ginseng is 15 to 18 ℃. In April-June a soil temperature of 15℃ is rarely reached in the Lytton area. Cooler soil temperatures favor damping-off. *R. solani* is active in moist soils at 8℃ when plants start to grow in spring.

Prevention of Damping-Off

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 sandy loam to loam that drains well. B.C.'s arid interior with hot, dry weather should have fewer disease problems than cooler, wetter locations. Good soil fertility and a soil pH 5.5 -7.5 will sustain good ginseng growth while heavy fertilizer or manure applications could cause plant stress and increase disease problems.

Avoid poorly drained heavy soils and uneven terrain with hollows where soil moisture will accumulate and increase damping-off.

Purchasing Seed

Use only the highest quality seed available. There is little likelihood that diseases will be carried on the seed surface due to the stratification process involving seed immersion into formaldehyde. Seed should be clean and should not carrry pieces of debris that could be contaminated with diseases. Little information is available regarding diseases carried on the seed. Damping-off fungi are spread with soil and debris and would not likely be introduced on the seed. This may not be the case with foliar diseases such as *Alternaria* or *Phytophthora* blights where seeds could become infected.

Seed Treatment

An important prevention for damping-off is the use of a seed treatment such as thiram, thiram plus carbathiin or captan to provide a protective coating over the seed just prior to seeding. How effective this treatment is remains unknown. It is unlikely that any fungicide residue would persist from October seeding to March when damping-off becomes active. The fungicide might reduce fungal inoculum in the vicinity of the seed.

Routinely monitor the crop to check for any unusual symptom. Especially check low, wet areas of the field or in the center of large gardens where air circulation is poor

Accurately identify the cause of the plant problem. A sample of affected plants and roots can be sent to your local B.C. Ministry of Agriculture and Fisheries office or mailed to:

Provincial Plant Diagnostic Lab
17720-57th Avenue
Surrey, B.C. V3S 4P9
Telephone: (576-1911)

When mailing a plant sample, wrap the roots and leaves separately between paper towelling. Do not use plastic. Serious economic loss can be avoided by accurate identification of the problem and immediate application of control measures.

Management and Establishment Practices

Create raised beds that are sufficiently high, 30 cm (1 ft.) for improved soil drainage. Plant seed at an optimal density 5×12 cm (2×5 in.) in beds to allow for proper development and air circulation. Research has shown that a plant spacing of 7.6 cm (3 in.) reduced the rate of spread of *R. solani* compared to closer spacings of 1.2-5 cm (.5-2 in.). Use the recommended seeding depth at 2-2.5 cm, (.75-1 in.). Deep seeding will deplete seed reserves and expose the germinating seedling to the root destroying fungi for a longer length of time. During the first and second year of a ginseng garden, guard against damping-off by keeping plants slightly drier and taking care not to over-irrigate. If damping-off appears, strictly limit irrigation to allow the soil to dry out. Irrigate at dawn so that the dew period is not prolonged. Avoid irrigating with cold water

at mid-day. Ontario growing conditions are wetter with high humidities. First and second year ginseng gardens in ontario are not irrigated.

Control of Damping-Off

Once damping-off has been identified in a ginseng garden, control steps should be immediately followed to prevent spread.

Dispose of diseased plant debris as soon as possible so that it will not be transported throughout the garden on machinery or water runoff. Collect and remove the diseased plant material to a site away from the ginseng garden.

Spot treat patches of damping-off by sterilizing the soil with steam, heat or a fumigant such as formaldehyde, Terrachor, Vapam or Vorlex. Allow sufficient time for the treatment to dissipate before transplanting seedlings from higher density areas into these bare patches. This should only be done on a trial basis with great care to avoid harming adjacent plants.

When symptoms of damping-off first appear high volume fungicidal drenches may slow down disease spread. Sprays to the foliage will be ineffective for controlling root problems and damping-off. High water volume is essential for fungicidal drenches in ginseng plantings to penetrate the straw mulch.

Registered Fungicide for Damping-Off

Quintozene 75 WP (PCNB, quintozene)

Quintozene 75 WP was registered in Canada (1989) to control Rhizoctonia crown rot and damping-off in ginseng. B.C. ginseng growers can now use Quintozene 75 WP only where crown rot and damping-off caused by Rhizoctonia have been identified as the problem. The following outlines the proper use of Quintozene 75 WP.

Timing and rate

Quintozene 75 WP is best applied early in spring before any green tissue emerges from the soil. Apply Quintozene 75 WP at the rate of 9 kg/ha in 3400 to 4500 litres of water per hectare. This high volume of water or application just prior to rain is needed to move Quintozene 74 WP through the mulch and into the soil.

Ontario ginseng growers use Agral 90 surfactant to assist in movement of the chemical to the roots.

Application of Quintozene 75 WP can be made the first year prior to seedling emergence and in the second year again prior to plant emergence. Only one application of Quintozene 75 WP can be made per year.

Caution Possible Plant Damage

Phytotoxicity or damage to ginseng plants could occur if Quintozene 75 WP is applied to tender or stressed plants.

Strictly adhere to lable recommendations and safety precautions as Quintozene 75 WP is a toxic chlorinated hydrocarbon.

Fungicides Used for Ginseng in Wisconsin

Ridomil 5 G (metalaxyl) is specifically effective against *Pythium* and *Phytophthora sp.* but not other fungi. Application of the Ridomil granules is made in Wisconsin once a month during the growing season for control of *Phytophthora* blight.

Spot treatments of zineb and maneb have proven effective against *Phythium debaryanum* and showed an increase in seedling fresh weight in Eastern North America. PCNB (Terrachlor, quintozene), Benomyl (Benlate) and Rovral (iprodione) drenches effectively controlled *R. solani* while captan and difolatan had a lesser effect. No fungicide effectively controlled *Fusarium*. Maneb, zineb and captan were reported phytotoxic to ginseng after three applicatios.

Phytophthora Leaf Blight and Root Rot

Caused by: *Phytophthora cactorum*

The most threatening of all ginseng diseases is *Phytophthora* root rot. Uncontrollable epidemics in Eastem North America jeopardize the entire industry. *Phytophthora* root rot of ginseng is very similar to late blight that attacks and destroys potato crops. The fungus is effectively spread by wind and rain or irrigation splashing that carries spores to the foliage the downwards to the roots. The root rot phase is reason for major concern because ginseng unlike a potato crop is susceptible to infection for four seasons before the crop is harvested. Control

of *Phytophthora* root rot is our greatest challenge. Great difficulties arise because the fungus survives in the soil and the foliar phase of the disease is spread by wind which makes containment inpossible. Fungicidal sprays are aimed at controlling the foliar blight phase before the disease reaches the roots. If root infection does occur Ridomil (metalaxyl) sprays may suppress but will not eradicate or entirely control the disease. Prevention of the foliar blight phase of the *Phytophthora* disease is essential. Fortunately, we have not seen *Phytophthora* blight on B.C. ginseng.

Symptoms of *Phytophthora* Blight

Leafblight caused by *Phytophthora* can look similar to *Alternaria* leaf spot. Water-soaked spots form on the leaf surface then become brown and dry. Leaves with *Phytophthora* infection develop larger brown irrengular-shaped blotches but these lesions do not have a concentric ring pattern or target-board pattern like *Alternaria* blight. The foliage becomes discolored, wilts and dies. *Phytophthora* root rot is distinguished by the brown discoloration of the root surface and interior vascular ring of the root becomes distinctly dark brown. A characteristic foul, rotted odour is associated with ginseng *Phytophthora* root rot. Another diagnostic technique for root rot is to squeeze the root which feels soft and the interior root tissue comes out pasty like a tube of toothpaste. Roots entirely disintegrate and eventually the whole garden is unproductive.

Disease cycle of *Phytophthora cactorum*

The fungus *Phytophthora* is soilborne so it can readily survive the winter or is harboured in infected foots from the previous year. Wind and rain, irrigation and movement of equipment and workers readily spread the fungus. Cool, wet, humid conditions favor the development and spread of *Phytophthora*. In potato crops a prediction programme to forecast the first infection period has been devised using daily records of the temperature, relative humidity and precipitation. Such a programme has not yet been devised for ginseng crops and would require further research. Once the disease has established itself on the foliage it is further spread by wind, rain, irrigation and cultural operations even pesticide spraying. Spores of the fungus are carried downwards by rain or irrigation to the roots which become infected and begin to rot. By residing in the soil and roots *Phytophthora* is protected from pesticide sprays and continues to spread and develop throughout the life of the garden.

Prevention of *Phytophthora*

Avoid potential *Phytophthora* problems by carefully selecting planting sites. Avoid poorly drained sites and heavy clay soils.

Treat seed at planting with a fungicide such as thiram, thiram plus carbathiin or captan as a precaution against possible introduction of *Phytophthora* on the seed.

Poor soil drainage, excessive rainfall or irrigation, dense planting and poor air circulation favor disease development. Wisconsin growers use a high seeding rate of 120 pounds per acre to offset plant loss due to diseases yet higher plant densities also increase diseases.

Closely monitor the crop throughout the season for any sign of disease.

Control of *Phytophthora* Leaf Blight

Apply a fungicidal spray as soon as the disease is first observed. If the planting had blight the previous year then begin the first spray when foliage starts to emerge in spring and continue at regular intervals until the end of the growing season. In Canada no fungicide is registered for control of *Phytophthora* blight although Dithane M-45 used against *Alternaria* leaf spot will also control *Phytophthora* leaf blight.

Wisconsin

Growers in Wisconsin apply Ridomil 5G (metalaxyl) once a month just prior to rainfall for *Phytophthora* root rot control, while weekly sprays of Dithane M-45 control the leaf blight phase. *Phytophthora* foliar outbreaks occurred in 1986 in Wisconsin ginseng because at that time Dithane M-45 was not registered. In previous years and again in 1987, a special section 18 emergency registration allowed for the use of Dithane M-45 and Ridomil 5G on ginseng. Growers also use fixed copper spray for *Phytophthora* blight control.

Ontario

Growers in Ontario do not treat their crops for

Phytophthora foliar blight which is not a problem. Root rots remain inadequately controlled.

Ginseng Alternaria Leaf Spot and Stem Rot

Also referred to as *Alternaria* Leaf Blight Caused by: *Alternaria panax*

The Importance of *Alternaria* Leaf Spot and Stem Rot

Ontario and Wisconsin annually battle *Alternaria* leaf spot and stem rot caused by the fungus *Alternaria panax*. Weekly fungicidal sprays are applied to ginseng crops to avoid major economic losses. Early in the growing season leaf spots develop and rapidly spread throughout the planting causing severe defoliation. Third and fourth year crops are at a greater risk because of their dense foliage, higher humidity and poorer air circulation. A film of moisture on the leaf surface from dew, rainfall or irrigation is all that the *Alternaria* fungus requires to infect a leaf. Fortunately fungicidal sprays are available and effective in controlling this disease.

Symptoms of *Alternaria*

The first obvious symptoms of *Alternaria* infection are brown spots up to 2.5 cm (1 in.) in diameter that form on ginseng leaves and stems. The spots are papery dry and may have a ring pattern of light and dark brown resembling a target board. Severely infected plants become defoliated, wilt and die. Seed heads and roots can also become infected by *Alternaria*.

The Disease Cycle

Alternaria survives the winter on diseased crop debris. The fungus becomes active early in the season as plants begin to grow. Wind, rain splashing and irrigation disperse the fungal spores which come to land on ginseng plants. Spores are microscopic infective propagules which are produccd in abundant numbers by fungi. Cooler, wet weather, high relative humidity and poor air circulation promote *Alternaria* outbreaks as experienced in eastern North America. Disease development and spread slows down with hot dry conditions and low humidity. A film of moisture on the leaf surface from dew, rainfall or irrigation is necessary for infection. The leaf spots and larger brown blotches may first appear on plants in low, wet, humid spots.

Prevention of *Alternaria* Leaf Spot and Stem Rot

Avoid introducing the disease into new areas by using top quality seed treated with a fungicide such as thiram, thiram plus carbathiin, benlate or captan.

Regularly monitor the field throughout the growing season so that controls can be implemented immediately at the first sign of any disease.

Environmental conditions play a major role in determining disease outbreaks. Wet, humid condition and poor air circulation favor leaf spot and stem rot.

Irrigate right at dawn or earlier so that the dew period is not extended.

Keep foliage as dry possible.

Excessive fertilizer or manure forces excessive foliar growth that can make plants more susceptible to disease.

Follow recommended seeding rates and spacing. High plant densities reduce air movement and increase the humidity favoring diseases.

Control of *Alternaria* Leaf Spot and Stem Rot

Once the disease has been identified, control steps must be implemented immediately.

Collect and destroy the leaves of the first diseased plants that develop *Alternaria* as quickly as possible. Foliar removal is only practical on a small scale but can help to reduce the disease inoculum and prevent further disease spread.

Thoroughly spot treat the site where *Alternaria* leaf blight was first noticed by spraying the plants and drenching the soil with one of the fungicides listed below. Thoroughly spray the plants in the vicinity of the outbreak as well with one of the fungicides listed below.

Protect the planting from further spread of the disease by applying a fungicidal spray at the first sign of disease. Follow a weekly spray schedule. The fungicides will not eradicate existing infections but will protect existing foliage and stems from further infection. Be sure to thoroughly spray the foliage including upper and lower leaf surfaces and

stems.

The three fungicides registered in Canada for control of *Alternaria* leaf spot and stem rot are:

Dithane M-45 (mancozeb) at 4.4 kg/ha

Note: Use 1/2-1/4 the rate of Dithane M-45 on lst year ginseng seedlings to avold damaging the leaves (phytotoxicity)

Rovral 500 g/kg (iprodione) at 1.1 kg/ha

Dyrene 50 WP (anilazine at 4.4 kg/ha)

Use at least 2000L of water per hectare. Wait 30 days from application to harvest.

Use a different fungicide each week to reduce the chances of developing resistant strains of the fungus and lessen the buildup of fungicide residue of any one product in the root. A broader spectrum of antifungal activity can be expected. Wisconsin already has been identifying Rovral resistance in *Altemaria.*

Suggested Weekly Spray Schedule

Week Number	Fungicide
1.	1. Dithane M-45
2.	2. Dyrene
3.	1. Dithane M-45
4.	3. Rovral
5.	1. Dithane M-45
6.	2. Dyrene
:	:

Note: See chart of chemicals Registered on Ginseng in B.C. as Appendix 4

Note: Spray Dyrene in the evening or early morning or on a cloudy day to avoid phytotoxiciy.

Rovral (iprodione) is also effective agaist *Rhizoctonia solani*

Rovral (iprodione) and Dyrene (anilazine) are also effective against foliar disease caused by *Botrytis, Sclerotinia* and *Didymella.*

Wisconsin growers use Rovral (2 lb/acre) which is the only fungicide that they have registered on ginseng. In Wisconsin, Dithane M-45 had an emergency section 18 registration for *Alternaria* blight on ginseng in 1987.

Bravo is effective against *Alternaria* blight but is not registered in Canada or the U.S. for ginseng.

Rusty Root or Rust of Ginseng

Probable Cause-Cylindrocarpon (previously Ramularia) and/or Fusarium

Typically in B.C. this condition causes a rusty condition on the top half of the root, although it can appear lower down. This has no relationship to foliar rusts that appear on other plants.

It starts with small reddish lesions that can expand to circle the root. Generally these do not penetrate too deeply and may even slough off to leave healthy tissue underneath, although a depression is seen where the 'Rust' was. It may also attack the underground stem as well, causing wilting and/or death of the tops. This condition may be severe enough to cause death of the root but generally does not. The fungi *Cylindrocarpon* and *Fusarium* are often found in association with this condition and are the suspected cause, but this is not proven.

Literature suggests that other conditions such as alkaline soil or waterlogged soil may enhance the 'Rust' on the roots. Nutritional factors such as low boron may also play a part in this condition. A more complete discussion of this is found in the publication "Diseases of Cultivated Ginseng" (See Appendix No. 1).

Another condition also called 'Rust' or 'Rusty Root" is where the rot typically starts at the root tip moves upwards. This condition affects the outer layers first but eventually the core is attacked and the whole root dies. These rotting areas are always dry and firm, and again *Cylindrocarpon* and *Fusarium* are suspect but not proven. This latter condition is not found to date in B.C.

Control of these conditions has not been established and although pre-planting fumigation of soil is helpful, is not recommended because it destroys beneficial organisms.

Harvesting

Ginseng is harvested after 4 growing seasons and much care and attention is required at this stage to ensure a top quality product.

First of all the posts, cables, shade material and

straw mulch all need to be removed from the field. This allows complete access to the rows. Ginseng, as far as we understand, cannot be replanted into this area again, so there is no reason to leave any structures (see Replant Problems section).

The mulch can be removed by hand or pushed off with a tractor and blade. Many inventions have been used to remove straw but a blade shaped similar to the bed shape and attached to a front end loader seems to be the most popular.

Small areas can be hand dug, but if you have a larger area there is a need for mechanization. For large areas, potato type harvesters are generally used. The root is dug with this and allowed to fall back on the ground. There are three companies making these diggers (See Appendix No. 2) and recently one of these companies has manufactured a larger digger with self loading mechanisms, eliminating much of the hand picking. When digging, care must be taken to dig deep enough to get below the roots so they are not broken or cut off by the digger. You must also go slow enough so the pressure of the digger does not crush the roots. A tractor with a creeper gear is necessary when harvesting as slow speeds must be attained.

Once the roots are dug and laying on the ground, larger lumps of dirt are removed from them and they are picked up from the field and taken to the washer. A second or third pass with the digger is always done to assure that all roots are retrieved.

Yields at the end of a four year production cycle can be very variable. Literature indicates harvest yields from basically zero to 4480 kg/ha (4000 lbs/acre). The average is considered to be 2240 kg/ha (2000 lbs/acre) with an excellent crop in the 3920 kg/ha per acre (3500 lbs/acre) range of dried root.

Washing

Immediately following harvest, the roots need to be washed. For small amounts this can be done with a garden hose. For larger amounts there are commercial washers available. Some larger growers use only a garden hose believing that they achieve a better quality product.

Washing of this crop sounds simple but there are a couple of things that must be kept in mind. The first thing is that "almost all" of the dirt needs to be removed but the outside root tissues should be bruised as little as possible by washing or mechanical damage. This will give the root its acceptable appearance when dried. Failure to achieve this balance will reduce the quality of the root and subsequently the price. Experience is really the only solution for finding this balance. The products appearance affects the price even though the internal constituents remain the same.

Storage

Ginseng root can be stored for a considerable length of time before drying if dryer space is not available. A cooler with a fairly high humidity would be necessary. There is indication that root stored at 4.4℃ (40°F) for one to three weeks after harvest gives a better quality root when it is finally dried.

Another application would be where a grower develops a market for fresh root. After harvest in the fall, root could be maintained for some time in a cold storage unit.

Drying

This is one step in the production of ginseng where quality can quickly be reduced. Drying needs to be done with both air circulation and heat control, and venting to reduce the relative humidity.

Generally the root is dried in shallow trays with screen bottoms. This allows for good air circulation. If large amounts are grown the trays can be stacked, with space between them to give adequate air circulation to each layer. Dead air spots in the drying area can result in slow drying and the possibility of molds starting, which may cause decay.

The best method of drying seems to be where all the air has to flow up and through the tray or trays in the dryer. The DeCloet dryer, used in the tobacco industry has been adapted quite succenssfully for ginseng. A similar dryer could also be built. The trays are generally built to fit snugly

inside the dryer on the sides and ends causing all the air to flow from the bottom to the top, then either recirculated or vented outside. The Delhi Research Station has done an engineering study on drying ginseng in a DeCloet type dryer (See Appendix No. 1 for information source).

Heat is important in the drying process and the initial temperature generally would be lower than the final drying temperatures. The following are a few temperature regimes used by individuals willing to share their methods.

1. Start at 26℃ (80°F) and gradually increase temperature so it is at 43℃ (110°F) at the end of the drying period.

2. Start at 26℃ (80°F) increasing this up to 40℃ (105°F) near the mid-period then reduce back to 35℃ (95°F) at the end.

3. Start at 24℃ (75°F) for 5 days moving this gradually up to 29℃ (85°F) for 10 days then gradually to 32℃ (90°F) for the last 2 days.

4. Start at 37.7℃ (100°F) and keep it at this until the root is dry.

5. Start at 26℃ (79°F) and gradually go to 39℃ (102°F) near the end.

6. Start at 23℃ (74°F) for 2 days then up to 36℃ (97°F) and finally to 37.7℃ (100°F) after 4 days and hold it there till day.

All of the above are general and are based on an approximate 14 to 18 day drying time. This will vary with the type of dryer and the amount of air moving through the trays. If disease starts to form (mold) on the roots, increase the temperature sharply to 43℃ (110°F) to stop the growth. Some literature suggests that drying temperatures over 37.7℃ (100°F) may not be generally beneficial.

A condition known as "green root" sometimes occurs during the drying process. Once this happens it cannot be eliminated. It is attributed to the drying temperature being too low when the root is at the 28 to 30 per cent moisture level.

When the root is dried properly it should snap cleanly and leave a smooth white appearance at the break. It should not be brittle and break into pieces. Poorly dried root is easily recognized by most buyers and will give reduced returns.

Overheating will cause improper drying and the surface will discolour in the drying process.

The small roots may dry to a proper moisture content of approximately 6 percent of total dry weight in 10 days or so. Larger roots over 2.5 cm (1 inch) in diameter may take up to 3 weeks to dry. The above will vary with the weather at drying time. If it is rainy, it will take more time than if the outside air warm and dry.

Replant Problems

In the traditional ginseng growing areas, ginseng is not replanted on the same land that it was previously grown on. This situation is not clearly understood execpt that it isn't done. This means that you need an ongoing supply of new land if you continue to plant year after year. We as yet haven't determined whether there is a problem in B.C. or not. If you do try replanting in an area, do so with caution. It is suggested that there is a buildup of disease inoculum that the small plants cannot handle. There is no scientific basis for this, at this time.

It is also suggested that the root system releases a chemical into the soil while the plant is growing that interferes with the development of new seedlings. This is called an allelopathic condition and is generally one that interferes with other plant species but not itself. Some work has been done to date on this problem but no solution has been found.

Some literature suggests that this crop depletes the nutrients there is "nothing" left in the soil. This does not make sense, as we could very easily replace these nutrients in the soil and carry on. Other literature suggests for wild ginseng, that when you dig up a root, you replant a young seedling or seed there. This contradiction likely indicates a lack of knowledge and/or the lack of a problem.

Importing Shade Cloth

When you are importing shade materials and supplies from the U.S.A.. Customs Canada require an import number, supplied by the Privy Council of

Canada. This number is O.I.C., P.C. 1983-3414, November 3, 1983. Since these products are not manufactured in Canada, they are imported duty free as an agriculture product.

Importing Seed

This requires a permit from Ottawa before a supplier from outside Canada can ship seed to you. Fill out the form available from Agriculture Canada or a Ministry of Agriculture and Fisheries office and mail it completed in all areas, to Ottawa (address is on the form). Please give approximately four weeks for processing and mail time.

To rush the process in an emergency.

Fill out form and fax to Ottawa (613) 995-6833

Wait 2 days and phone Claire Martin in Kelowna at (604) 861-6048 who can pull the permit number off the computer and give details on how to proceed from there. See a reduced copy of this form as Appendix No. 6.

Exporting of Root

When you are going to export North American ginseng roots from Canada to the U.S.A. or any other country you need a CITES (Endangered Species) permit. These permits are available from Agriculture Canada Plant Protection office in Summerland will have to be sent back there for official stamping when the form is completed. See a reduced copy of this form as Appendix No. 5.

The address is
Agriculture Canada
Food Production and Inspection Branch
Agricultural Inspection Directorate
Box 397
Penticton, B.C.
V2A6K6

Marketing

This is an area that this publication will basically not address. There seems to be a good market for top quality product which when grown, is sold in containers lined with plastic bags to maintain quality. It is stored in a cool, dry place until sold. The actual marketing of ginseng at this time is left to the growers. There was a marketing study done in October 1988 for the Associated Ginseng Growers of B.C. by the Provincial and Federal Agriculture governments. It is titled "Assessment of the Market Potential for Ginseng Cultivated in B.C.". It is available from the association or the Ministry of Agriculture and Fisheries office in Kamloops.

There are many forms that ginseng can be marketed in, as you can appreciate by visiting a health food store, or shops catering to Oriental people. This also indicates a potential "added value" to this product, where the grower processes or packages the product in various ways.

This "added value" is an area that is developing in North America and has been in place in the Orient for many years. Our grading process is very simplistic compared to the standards of countries such as Korea, where there are numerous grades of roots that are sold to specific markets.

Summary

As with any crop, there are many things that need to be done to achieve success. It must be emphasized that this is one crop that demands 100 percent or more. This is a high input crop, a long term crop, a labor intensive crop and a high return crop. However, to get the returns you cannot take shortcuts or go half way. It is essential that you do your homework before you commence this venture.

This factsheet is designed to cover the basic steps involved in growing ginseng and some of the details. It does not contain all the bits and pieces of information needed. Many of these are practical, many are solved "on the farm" and many necessary items can be purchased at the local hardware store.

We suggest you do not venture into this crop until you have done your homework. At this time, we do not pretend to have all the answers and this publication serves only as a guideline.

We wish you well in this new agricultural industry in B.C.

Appendix No.1

Sources of Information and Books

1. Ginseng, a production guide for North Carolina
   by T.R. Konsler, Department of Horticultural Sciences.
   Available from: North Carolina Agricultural Extension Service
   North Carolina State University
   Raleigh, N.C. 27607
2. Cultivating Ginseng in Kentucly
   by the University of Kentuky-English et al
   Available from: Conllege of Agriculture
   University of Kentucky
   Room S-105
   Agricultural Science Building-North
   Lexington, Kentucky 40546
3. Diseases of Cultivated Ginseng
   by J.L. Parke and K.M. Shotwell
   Available from: Agricultural Bulletins
   Room 245
   30 North murray Street
   Madison, WI 53715
4. American Ginseng Culture in the Arid Climates of British Columbia
   by A. Oliver, B. Van Lierop and A. Buonassisi
   Availavle from: B.C. Ministry of Agriculture and Fisheries
   162 Oriole Road
   Kamloops, B.C. Canada
   V2C 4N7
5. American Ginseng-Green Gold
   by W. Scott Persons
   Available from: Dickman Company Publications Department
   Box 296
   Willow Springs, MO 65793
6. All About Ginseng
   by John W. Epler Jr.
   Available from: Spearman Publishing and Printing
   Box 500
   Sutton, Nebraska 68979
7. Ginseng, the Magical Herb of the East
   by Stephen Fulder, M.A. Ph. D.
   Available from: Dickman Company Publications Department
   Box 296
   Willow Springs, MO 65793
8. Ginseng, the Myth and the Truth
   by Joseph P. Hou
   Publishers: Wilshire Book Company

12015 Sherman Road
N. Hollywood, CA 91605
(213) 875-1711

9. Ginseng "The Divine Herb"
   Available from: Century Publishing
   204 Holt
   Summit, MO 65043
   (314) 896-4968
10. Methods to Utilize Tobacco Kilns for Curing (Drying) and/or Storage of Alternate Crops.
    by D.L. van Hooren & S.J. Ratavicius
    Available from: Ag. Energy Center
    Quelph Agriculture Center
    Box 1030
    Guelph, Ontarion
    N1H 6N1
11. Ginseng, What It Is…What It Can Do For You
    by Ben Charles Harris
    Available from: Keats Publishing Incorporated
    36 Grove Street
    New Canaan, Connecticut 06840
12. How to Raise Two Cash Crops For Profit
    Ginseng and Golden Seal
    by M.A. Dickman
    Avalable from: Dickman Company Publication Department
    Box 296 Willow Springs, MO 65793
13. The Tao of Medicine
    by Stephen Fulder, Ph. D.
    Available through health food stores or
    In Canada from Alive Books, Vancouver, B.C.
14. Ginseng, Plant of Life
    by Rodndy Brown
    Avalable from: Dickman Company Publications Department
    Box 296
    Willow Springs, MO 65793
15. American Ginseng Trends (monthly publication)
    Avalable from: Future Concepts Inorporated
    Box 1982
    Wausau, WI 54402-1982
16. Curran's Ginseng Farmer
    P.O. Box 3141
    Missoula, MT 59806

Ginseng Grower Associations in N. America

Ginseng Growers Association of Canada
Box 87

Wisconsin Ginseng Growers Association
Suite 202-2

Waterford, Ontario
N0E 1Y0
American Ginseng Research Institute
500 Third Street
Suite 208-2
Wausau, WI 54401 (715)

The Associated Ginseng Growers of B.C.
Box 241
Vernon, B.C.
V1T 6M2

500 Third Street
Wausau, WI 54401
Illinois Ginseng Growers Association
Box 462
Watseka, IL 60970

Ginseng Board of Wisconsin
2204-9 th Avenue
Hamburg, WI 54438

New York State Ginseng Assocaition
Roxbury, NY

Appendix No. 2

Sources of Seed, Equipment and Supplies

Friday Tractor Company Incorporated 69226 CR 687 Hartford, MI 49057 (616) 621-3318	Straw Spreaders
Panax Limited 7015 West Stewart Avenue Wausau, WI 54401 (715) 845-5003	Shade Cloth and Related Hardware
Buetsch Implements Incorporated Rt. 1 Box 236 2891 Highway South Marathon, WI 54448 (715) 443-2276	Tractors-Sprayers Diggers-Seeders
Grayco Potato Harvesters Ltd. Box 86 Heidelberg, Ontario, Canada N0B 1T0 (519) 699-5372	Digger
Gallenberg Equipment W9112 Cherry Road Antigo, WI 54409 (715) 623-3754	Diggers Washers Sprayers
Hardi Incorporated 477 Exeter Road London, Ontario N6E 2Z3 (519) 685-6730	Hardi Sprayers
Farmers Equipment Co. Box 393 Lynden, WA 98264 (206) 354-4451	Modified Tractors Sprayers Other specialized equipment
Flexi-Coil Limited P.O. Box 1928 Saskatoon, Saskatchewan	Post Pounders (also available at most local implement dealers)

S7K 3S5 (306) 933-0660	
Pak Unlimited West	Shade Cloth & Related Hardware
12403-136 th Avenue East	
Puyallup, WA 98374 (206) 845-9453	
Grief Containers Incorporated	Fibre Drums
Box 191	
Lloydminster, Alberta	
S9V 0Y1 (403) 875-4421	
Van Waters & Roges	Nematacides & Applicators
#5-1851 Kirschner Road	
Kelowna, B.C.	
VIY 4N7 (604) 762-2066	
Tatro Irrigation & Potato Equipment	Diggers
1619 County K	
Custer, WI 54423 (715) 592-4650	
Wausau Canvas Company Inc.	Shade Cloth
801 Jefferson Street	
Wausau, WI 54401 (715) 854-6614	
Delhi Foundary and Farm Machinery Ltd.	Root washers
171 King Street West	
P.O. Box 188	
Delhi, Ontario N4B 2W9	
Hsu's Ginseng Enterprises Inc.	Seed, Purchase & Sales
T6819 County Hwy. West	Roots Purchase and Sales
Box 509	Ginseng Product Sales
Wausau, WI 54401 (715) 675-2325	
Condon Ginseng Farm Incorporated	Seed-green & stratified
4300 West Stewart Avenue	Root-buyer
Wausau, WI 54401 (715) 845-5446	Shade Materials
B & B Ginseng	Seed-green
R.R. #1, Site 19A, Comp. 20	-stratified
Vernon, B.C.	
V1T 6L4 (604) 545-4737	
White's Ginseng Farm	Seed-stratified
10900 Coldstream Creek Road	Used Stranded Cable
Vernon, B.C.	
V1B 1C9 (604) 542-1984	
Arndt Enterprises	Shade Materials
N3470 CTHE	
Medford, WI 54451 (715) 748-4459	
A & B Sales Incorporated	Ginseng Farming Machinery
8601 State Highway 107 North	
Marathon, WI 54448 (715) 443-2339	
Allan Smith	Seed
11310 Palfray Drive	
Vernon, B.C.	

V1B 2B1 (604) 542-1816	
MGM Fumigating	Soil Fumigant
R.R. #2, 33865 Farmer Road	
Abbotsford, B.C.	
V2S 4N2 (604) 852-2947	
Albert Hannah	Custom Seeding
9451-64th Avenue	
Grande Prairie, Alberta	
T8W 1B4 (403) 539-3741	
Noble Tractor & Equipment	Modified tractors
4193 Noble	
Armstrong, B.C.	
V0E 1B0 (604) 546-3141	
Nancy Millar	Stratified Seed
Box 460 Clearwater, B.C.	
V0E 1N0 (604) 677-4221	
Taku Ginseng	Custom Bedformer
General Delivery	Custom seeding and straw spreading
Walhachin, B.C.	
V0K 2P0 (604) 457-9922	

Other Possible Sources of Seed Equipment & Supplies (Not Verified by Authors)

Red Alderman
Watauga Herb Company
Rt. 2, Box 968
Boone, NC 28607
(704) 262-5358

Paul Bailey
Rt. 2, Box 132
Mars Hill, NC 28754
(704) 689-4595

Anthony or Gary Cole
Rt. 4, Box 2005
Leicenster, NC 28748
(704) 683-2697

Bill E. English
American Ginseng Gardens
RT. #2, Box 168-D
Flag Pond, TN 37657
(615) 743-3700 evenings

Donan Jenkins

Arlon Schmidt
Marathon, WI 54448
(715) 845-1486

Max T. Shelton Jr.
103 Big Creek Road
Marshall, NC 28753
(704) 656-2458

Barney L. Frye
Barney's Ginseng Patch
Rt. #2, Box 43
Montgomery City, MI 63361
(314) 564-2575

Jim Machen
Natures Cathedral
2250 14th Avenue
Marion, Iowa 52302
(319) 377-5085

F.B. and W. H. Collins
Viola, Iowa 52350

Box 74
Sturgis, KY 42459
(502) 333-2249

Norbert Jenson
2285 Springbrook Road
Mosinee, WI 54455
(715) 443-2033

Fred Markus & Sons
RFD 2, Box 185
Lawrenceburg, TN 38464
(615) 762-7765
Morris Pickerel, Sr.
Green Gold Ginseng Company
Thompkinsville, KY 42167
(502) 487-6411
Scott Persons
Box 236
Tuckasegee, NC 28783
(704) 293-5189
Dr. Ed Richards
P.O. Box 286
Salisbury, NC 28145

(319) 854-6600

Pulvermacher Buckhorn Ginseng
R.R. #4
Richland Center, WI 53581
(608) 647-2244-days
(608) 647-4820-evenings

Charles D. Holbrook
Route 1
Brodhead, Kentucky 40409

Appendix No. 3

Addresses of Major Importer/Exporters, Distributors and Processors

Sun Ming Hong
24-26 Hillier Street
Hong Kong
Tel. 5-435388 (Hong Kong)
(416) 979-9559 (Toronto)

Kiu Shun Trading Company Ltd.
261-269 Keefer Street
Vancouver, B.C.
V6A 1X6
(604) 682-2621

Tak Tai Trading (Canada) Inc.
195 St. Patrick Street
Suite 603
Toronto, Ontario

Lawrence Cheng
136 Lexington Avenue
New York, NY 10016

Raymond Chao
San Francisco, CA
(415) 362-1011

Chin Lin
San Francisco, CA
(415) 563-5670

Garwin Enterprise Corporation
2nd Floor, No. 2 Guang Ming Street
Kaohsiung, Taiwan

M5T 2Y8
(416) 597-0058

Tat Kong
Tack Kong Trading Company
57 Bryant Avenue
Edison NJ 08817
(201) 494-8812

Teck Shun Trading Co. Ltd.
138 East Pender Street
Vancouver, B.C.
V6A 1T3
(604) 687-6877

Superior Trading Company
837 Washington Street
San Franciso, CA 94108
(415) 982-8722

Pao Fung Trading Ltd.
Hang Wo Building
No. 72-74
Bonham Strand West
Hong Kong
Tel. 5-486166

Tak Tai Medicine & Drug Company Ltd.
60-64 des Voeux Road West
20th Floor, Wing Yue Building
Hong Kong
Tel. 5-489184

Herbert Chiu
110 Collingsbrook Blvd.
Scarborough, Ontario
M1W 1M3

Lee Yuen Fung Trading Compan
125 West 29th Street
New York, NY 10001
(212) 594-9599

Herbalife Products
Administration Office
P.O. Box 92459

Shin Liang Enterprise Company
82 Tihwa St. 1 Sec.
Taipei, Taiwan

Ta Ying Trading Company
No. 79-2 Sining North Road
Taipei, Taiwan

Lung Shen Enterprise Co.
No. 301 Kuei Sui Street
Taipei Taiwan

Hang Fat Trading Company
No. 322 Ming Seng West Road
Taipei, Taiwan

Young Fong Thai Sdn. Bhd
76 Jalan Petaling
5000 Kuala Lampur, Malaysia

Chinese Patent Medicines &
Medicated Liguors Centre
lst Floor, Selangor Complex
Jalan Sultan
5000 Kuala Lampur Malaysia

Sinma Medical Products (M) Sdn Bhd.
30 Jalan Manis Tiga
Taman Segar Batu 6 1/2
Jalan Cheras
5610 Kuala Lampur, Malaysia

Poon Keong Medical Hall
134-0A Jalan Jejaka
55100 Kuala Lampur, Malaysia

Robert Corr Naturals Inc.
P.O. Box 10437
Chicago, IL 60610
(312) 787-0550

Achema Co.
(312)234-3570 (Chicago)

Los Angeles, CA 90009-2459

Teck Choon Ginseng Hong
P.O. Box 10669
50720
Kuala Lampur, Malaysia
Tel. 03-2303511
Karlen Ginseng Company

Ginseng U.S.A.
John Rastle
P.O. Box 1341
302 South 4th Street
Wausau, WI 54401
(715) 845-4361

William J. Boehner & Company
259 West 30th Steet
New York, NY 1001
(212) 695-3435

Hsu's Ginseng Enterprises Incorporated
P.O. Box 509
Wausau, Wisconsin
54401-0509
(715) 675-2325

The Ginseng Company
P.O. Box 5108
Chatsworth, CA 91313
(818) 882-4211

Albi Imports Limited
7188 Curragh
Burnaby, B.C.
V5J 4V9
(604) 438-1054

Chung's Wine Products Limited.
3127 Underhill Avenue
Burnaby, B.C.
V5A 3C8
(604) 421-7474

Felicity Company
1578 Chestnut Street
San Franciso, CA 94123

R.P. Sherer
P.O. Box 5600
Clearwater, Fla 33518
(800) 237-0958

Beijing Trading company Limited.
89 East Pender Street
Vancouver, B.C.
V6A 1S9
(604) 685-2736

Canadian Ginseng Compnay Limited.
Authorized Sole Agent In Canada
For Korean Red Ginseng
33 East Hastings Street
Vancouver, B.C.
V6A 1M9
(604) 681-9888

Jade Ocean Holdings Limited
2615 East 49th
Vancouver, B.C.
V5S 1J9
(604) 432-7212

Ten Ren Tea & Ginseng
550 Main Street
Vancouver, B.C.
V6A 2T9
(604) 684-1566

The above list of importers/exporters, distributors and processors comes largely from the publication "Assessment of the Market Potential for Ginseng Cultivated in B.C.", Project No. 13001 under the Canada-British Columbia Subsiduary Agreement on Agri-Food Regional Development, prepared for the Associated Ginseng Growers of B.C., October 1988, by Don Ferrence and Associates Ltd., Suite 550-475 West Georgia Street, Vancouver, B.C.

Note: A weekly fungicidal spray programme may be required for ginseng. Alternate fungicides so that a different fungicide is used each week to reduce the chances of developing resistant strains of fungus.

Fungicides Registered on Ginseng in B.C. (January 1, 1990)

Fungicides Registered On Ginseng In B.C	Fungicide Name	What It Will Control	Registered Status	What It Will Not Control	Comments
Dithane M-45 −foliar protectant fungicide	mancozed	Alternaria Phytophthora Pythium Rhizoctonia Botrytis	Reg. Not Reg. Not Reg. Not Reg.	Sclerotinia	−4.4 kg/ha Dithane M-45 −use 2000 L water/ha for thorough coverage −wait 30 days from application to harvest −may burn on a hot day −reduce rates for seedlings
Rovral −foliar contact fungicide with preventative and curative action	iprodione	Alternaria Rhizoctonia Botrytis Sclerotinia Fusarium	Reg. Not Reg. Not Reg. Not Reg. Not Reg.	Phytophthora	−1.1 kg/ha Rovral 50 WP −use 2000 L water/ha −wait 30 days from application to harvest −will build up resistance to this chemical quickly so alternate with other fungicides −do not apply with wetting agent
Dyrene −foliar protectant fungicide	anilazine	Alternaria Botrytis Phytophthora Rhizoctonia	Reg. Not Reg. Not Reg. Not Reg.	Fusairum	−4.4 kg/ha Dyrene 80% −use at least 2000 L water/ha −wait 30 days from application to harvest −spray early morning or on a cloudy day to prevent phytotoxicity −apply uniformly as it requires good coverage of foliage
Quintozene 75 WP −soil fungicide only, used as a drench	quintozene (PCNB)	Rhizoctonia crown rot and damping-off Botrytis	Reg. Not Reg.	Fusarium Pythium Alternaria Phytophthora	−9 kg/ha Quintozene 75 WP −use 3400-4500 L water/ha −apply only once per year in early spring before any growth starts or green tissue emerges from the soil −do not apply in harvest year −use Agral 90 to assist in carrying chemical to roots −no other root crops to be grown for one year following ginseng havest