Production and Propagation of American Ginseng (*Panax quinquefolius*) in North America—a New Zealand Perspective

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INTRODUCTION

Ginseng is an herbaceous perennial that is cultivated for its highly valued root. It is purchased as whole dried roots, pieces of root, powdered, or in capsules, and it is used in teas, soups, wines, and in a wide assortment of herbal and cosmetic preparations. Ginseng is used mainly in Asia, although its use is gaining popularity in other cultures. American ginseng (*Panax quinquefolius*) is a close relative to the Asian or Korean ginseng (*P. ginseng*). Both species are of economic importance and each has a distinct use in Chinese medicine. The main commercial production areas in North America of American ginseng are Wisconsin and Ontario with significant expansion in recent years in British Columbia. Interest in the production of this crop is high and expansion in North America is likely to continue.

GROWING CYCLE

Ginseng is propagated by seed which germinates after a lengthy stratification period. After germination 1-year-old seedlings produce three coarsely serrated leaflets joined at the top of a 5- to 10-cm stalk. In autumn the leaves senesce with the plant overwintering as a root similar in shape to a small carrot. In the second year plants produce two compound leaves at the top of a 10 to 20 cm long stem. Older plants may have three, four, and sometimes five compound leaves. Most ginseng plants flower after their third year, although flowers are sometimes found on two year old plants. The number of flower clusters and subsequent seed numbers increase as the plant ages but this is also dependent on plant vigour. The fruit ripens in late summer to a deep red colour and usually contains two hard-coated seed. In its native environment ginseng can grow for many decades. Each year when the plant senesces the dead stem leaves a bud scar on the tuberous root. By counting the scars the age of the plant can be determined. Older plants which are extremely rare command very high prices when sold.

SITE SELECTION

Careful site selection is essential for this crop. Factors to consider include climate, soil characteristics, aspect, slope, and previous land use.

Climate. American ginseng is a native of North American temperate hardwood forests from Georgia to Canada. The geographic range extends between 34° to 45° north latitude in eastern North America. This region generally experiences a continental climate with hot dry summers and cold winters. Two important

factors to consider when choosing a climate suitable for growing ginseng include:

1) The need for a prolonged cold stratification period for both shoot emergence and seed germination.

2) Ginseng seems to have little resistance to diseases which thrive in cool wet conditions. The most notable, *Phytophthora* and *Cylindrocarpon*, can wipe out an entire crop over a period of days given the appropriate conditions. A comparison of climate data between New Zealand and the main growing areas in North America (Table 1) indicates that possible New Zealand sites are warmer in the winter and have fewer degree growing days in the summer. Given these constraints it follows that the most successful production of ginseng in New Zealand is likely to be in those areas that have cold winters and dry hot summers. Although not as cold in winter or as hot in summer, likely areas in New Zealand include parts of the central North Island and most of the South Island. Production in North America also includes areas that have high rainfall (see Table 1). Production in these areas is often carried out under a forest canopy. The forest soils rarely become waterlogged because excess water is absorbed by the high organic soils or returned to the environment by transpiration. This may increase the number of possible areas for ginseng production in New Zealand by including much of the 1.2 million ha of plantation forest.

Table 1. Climate comparisons between traditional ginseng growing areas in North America and potential New Zealand growing sites.

Site	Mean annual rainfall (mm)	Mean July temp. (C)	Mean January temp. (C)	Degree days (>10C)	Air frost-free days
New Zealand					
Hamilton	1201	8.3	17.8	1376	228
Nelson	999	6.3	16.7	-	-
Christchurch	666	5.8	16.5	1067	206
Alexandra	360	2.5	16.5	889	112
Dunedin	691	5.0	14.7	791	195
North America[1]					
Lytton (British Columbia)	411	-0.5	29.0	1409	186
Simcoe (Ontario)	888	-5.6	20.6	1240	155
Wausau (Wisconsin)	646	-6.4	21.7	-	-
Asheville (North Carolina)	1524	2.9	23.2	-	-

[1] The data for the North American mean July and January temperatures are transposed to enable more meaningful comparisons to be made between hemispheres.

Southern Ontario the most popular soil for ginseng production are the "Fox" soils. These soils are comprised mostly of loamy sands down to about 80 cm. Below 80 cm the soils are composed of strongly calcareous sand. This results in soils that are well drained and rapidly permeable. They also have a low water-holding capacity which makes irrigation desirable in dry years.

Aspect. In practice ginseng is grown on all aspects but because it prefers a cool shaded environment a northerly (southerly in New Zealand) aspect is preferred.

Slope. Slope is important to provide good air and water drainage which assists in disease prevention. Machinery access is also important so excessive slope should be avoided.

Previous Land Use. Ginseng does not grow well on sites that have grown ginseng previously. There are anecdotal reports of land being spelled for up to 40 years and still not successfully growing a second crop. Often the crop will germinate and grow for one or two seasons but usually not through to a third year. Disease is implicated but researchers do not yet fully understand the reasons for this decline. Other crops which in Ontario grow well under a similar climate and soil type to ginseng include tobacco, maize, cereals, and horseradish. In Wisconsin land used for ginseng is also used for corn, cereals, and potatoes.

GINSENG PRODUCTION

There are four methods of producing ginseng in North America:

1) **Wild Crafting**. Wild ginseng is harvested from the woods. Because prices are high, excessive harvesting has resulted in ginseng becoming endangered in some states.

2) **Wild Simulated**. Ginseng is cultivated in the woods using a low input system to produce roots resembling wild ginseng.

3) **Woods Grown**. An intensive production system using the shade provided by a forest canopy. Most of the management systems (e.g., fertiliser and fungicide applications) are similar to intensive cultivation.

4) **Intensive Cultivation**. Ginseng is grown intensively using wooden lath or shade cloth, to provide the shade.

Land Preparation. Land planned for ginseng production is usually sown in a cover crop such as lucerne or buck wheat. After an initial cultivation animal manure is applied at rates of around 60 tonnes/ha or more. The manure is well worked in and if the farm is on stony soil the stones are removed. In July or August (January and February in New Zealand) the soil is often fumigated. Although fumigation is usually carried out in Ontario, it is less common in Wisconsin. In Ontario Vorlex at 30 to 80 litres/ha is most commonly used. Other soil fumigants used include basamid and methyl bromide. After allowing at least the recommended time for the soil fumigant to work, lime or gypsum is added to achieve a soil pH of 5.5 to 6.0. Any basal fertiliser applications are also made at this time. If soil drainage is likely to be a problem some growers also installed tile drainage. After the lime and fertiliser have been well worked into the soil, the posts and support structures for the shade are laid out. The beds are then formed and groomed in preparation for planting in September (March in

New Zealand). Beds are approximately 30 cm high at the centre. They must provide adequate height to allow a harvester to pass underneath without cutting the root and to provide good drainage while at the same time not being so high that the foliage is damaged when a tractor passes overhead.

Propagation. Commercially ginseng is propagated by seed which is harvested in late August and September (February and March in New Zealand). The seed needs an embryo-ripening period to germinate and requires temperatures at about 20C as well as a period of cold stratification. Typically seed is harvested in late August or early September (February or March in New Zealand) with approximate seed yields of 300 to 350 kg/ha and 400 to 450 kg/ha from 3 and 4 year old crops, respectively. After harvest the seed would either be passed through a depulping machine which separates the pulp from the seed or the seed pulp is allowed to ferment for 2 or 3 weeks, before washing the seed from the pulp. Once separated from the pulp the seed is 'floated' or placed in water. Only those seeds that sink are regarded as viable and any that float are discarded. Seed is then usually treated to reduce the incidence of fungal or bacterial attack. Treatments differ from grower to grower with the soaking of seed in a formaldehyde solution for 25 min being one of the most common treatments. Seed is then mixed with washed mortar sand in a concrete mixer. The ratio of seed to sand varies from grower to grower but is usually around 1 : 2. The seed and sand mix is then placed into especially constructed subterranean seed boxes for one year. Again the box dimensions vary greatly from grower to grower, however, a typical box is about 3 m long, 1.5 m wide, and 0.5 m deep. Wire mesh is used for the base of the box to prevent the entry of rodents. This is then covered with 7 to 8 cm of sand followed by the seed and sand mixure. The last 10 cm is filled with sand only. Mesh for rodent protection and shade to keep the seed cool are then placed on top of the box. During the summer an additional layer of shade may be placed about 2 m above the box. Care needs to be exercised when positioning the seed box as excessive drainage will cause the seed to dry out while insufficient drainage will cause waterlogging and the seed to rot. The exact causes of seed rot or "milky" seed are not well understood but the problem seems to get worse the deeper the seed is in the seed box. Likely causes are insufficient drainage, lack of oxygen, or warm temperatures. The seed box also needs to be regularly monitored so that if it starts to dry out, water can be applied. After one year the seed is lifted, sieved, and washed to remove the sand. The seed is again floated to remove non-viable seed and treated to help prevent fungal attack. The seed is surface dried then stored, usually in a cool store prior to sowing.

Seed Sowing. Seed should be sown as soon after removal from the seed boxes as possible to ensure that seed viability is not lost through excessive drying or disease. Prior to sowing the seed coat is surface dried to ensure it does not jam in the seeder. If a precision sower such as the stanhay is used, the seed is also graded to remove the larger seed that may not fit in the belts. There is also a general perception that seed with a split seed coat has been sufficiently stratified and is ready to sow; however, many growers try to avoid sowing split seed because of the damage that can be caused to this seed when passing through the seeder. If split seed is sown the radicle should be less than 1 mm

long. Seed is usually sown in September (March in New Zealand) although in Wisconsin some growers have sown with success as early as July (January in New Zealand) while growers sowing into the woods tend to sow later to avoid seed predation by rodents. Seeding is carried out using a variety of methods from precision sowers such as the stanhay, planet junior, or vicon down to manual hand-operated seeders such as the planet junior and sometimes for forest-grown ginseng seed is spread by hand. Often a precision sower is used for most of the beds with a manual push seeder being used to sow the top of the beds between the posts supporting the shade structures. Seed is sown at approximately 110 kg/ha onto raised beds. Eight to 20 rows can be sown per bed with 12 rows/bed being the most common. After seed sowing, a mulch (usually oat straw) is applied. Germination usually occurs in the spring following sowing however some seed may take an extra year before emerging. Crop thinning was never carried out with crop spacing being achieved through a combination of seed sowing rate, seed germination percentage, and attrition through disease. In North America it is common for plant numbers to be reduced by as much as 60% to 70% between sowing and harvesting. For wild simulated ginseng the leaf litter is removed, seed broadcast sown, and raked in. The leaf litter is replaced and the crop left with little or no further inputs until the crop is harvested.

Mulching. After sowing, the crop it is covered with a mulch which insulates the ginseng seed from excessive temperatures and helps control weeds. Most growers reportedly use either seed-free straw or sawdust. The usual mulching rate is one bale of straw for every 3.6 m of row in the first year and one bale of straw every 7.2 m of bed in the second and subsequent years. Most growers in Ontario use seed-free straw with a preference for oat straw.

Nutrition and Soil pH. Little scientific field evaluation of fertiliser requirements has been carried out with growers generally relying on field officers working for fertiliser companies to make suitable recommendations. This coupled with little published fertiliser research has resulted in a wide variation in fertiliser usage. Most growers aim for a pH of between 5.5 and 6.0.

Shade. Ginseng requires shade and will not grow without it. In North America shade is provided by either wooden lath, shade cloth, or by growing the crop under a forest canopy. Besides providing shade, artificial shade structures must be able to be removed during winter to avoid snow damage, relocatable once the crop has been harvested, allow tractor access, and not promote high humidity around the plant.

Pests and Disease. One of the main constraints to production of ginseng in North America is disease. This problem is compounded by the long period required to produce a crop and the difficulty growers have in getting fungicides registered for use on ginseng. Generally ginseng grown under a forest canopy suffers far less from disease than when intensively produced. The main diseases are *Phytophthora cactorum, Alternaria panax, Phythium, Rhizoctonia, Fusarium, Rhizoctonia solani, Cylindrocarpon* spp. (*Ramularia*), *Botrytis cinerea*, and *Stromatinia panacis* (*Sclerotinia panacis*). While host to a wide range of diseases ginseng is not host to many pests. The main pests are root knot nematode (*Meloidogyne* spp.), slugs and snails, and voles.

Harvesting. Ginseng roots are harvested, using modified potato harvesters, after the tops have started to die down but before the ground has frozen. This usually takes place in October (April in New Zealand). After digging the exposed roots are bagged by hand ready for drying.

Post-Harvest Handling. After harvesting roots are washed in water. Various methods are used from simple washing with a high pressure hose to the use of more sophisticated tumble washers. Roots are then either placed directly into a drier or cool stored. Cool storing of the root (at 7C) primarily adds flexibility for the grower who can harvest when conditions are most favourable rather than when drying space is available. Roots can be stored for a maximum of 6 to 8 weeks. After washing and possibly coolstoring roots are dried. Generally modified tobacco kilns are used. All growers have their own drying recipes but as a general rule roots are dried at approximately 38C for 10 to 14 days. Usually the crop will be sold as a single grade to a buyer or broker. The firm on whose behalf the broker is operating would then be responsible for grading, packaging, and resale. Ginseng is sold and transported in cylindrical cardboard barrels capable of carrying 45 kg of ginseng.

Marketing. Between 1983 and 1987 over 86% of the North American ginseng crop was marketed in Hong Kong with most of the crop going into China. The final price to the grower is dependent on the following factors.

- World supply of ginseng
- Exchange rates
- Market manipulations by the major importers and exporters
- Market demand related mostly to stability and standard of living in China
- Product characteristics which can include disease incidence, root age, root size, shape, condition, and method of cultivation.

Summary of production in North America. Ginseng is a significant minor crop in North America with a high profit profile. The most valued ginseng root is one harvested from the wild, followed by wild simulated, woods grown, intensively produced ginseng. A price premium is also given to older roots. The main constraint on production in North America is disease.

Potential for New Zealand. American ginseng appears to be a crop ideally suited to production in New Zealand. Ginseng when dried properly stores indefinitely and commands a high price on world markets. The main problem for New Zealand producers is that it is unknown as a producer and will be competing with the rapidly expanding production of the well known North American and Chinese producers. One of the main constraints on production in these traditional areas is disease which has had the result of decreasing the size of the root produced as growers harvest younger and younger roots. New Zealand growers could well command a market niche if they were able to grow larger older roots. Ginseng roots grown in the forest also command a price premium because these roots resemble wild ginseng. Another market niche could also be developed if ginseng were able to be successfully cultivated under a Monteray pine (*Pinus radiata*) plantation.

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