

HAZELNUT REFERENCE GUIDE

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This guide is published by the BC Ministry of Agriculture in partnership with the BC Hazelnut Growers Association. It is intended to be a first level introduction and evaluation tool to assist a new grower in making the decision of whether to enter the hazelnut sector. This publication provides an overview of the sector, discusses points that should be considered before starting a hazelnut orchard, and offers sources of information from other hazelnut production areas in North America. The guide is relevant to BC growing areas. Information has been compiled from BC hazelnut growers' experience, the Oregon State University Extension Service and the Ontario Ministry of Agriculture.

Information for this guide was compiled by Tom Baumann and Megan Fennerty and revised by BC Ministry staff in collaboration with Dr. Thom O'Dell of Nature Tech Nursery Ltd., and the BC Hazelnut Growers Association.

While care has been taken in the preparation of this guide, the BC Ministry of Agriculture and the BC Hazelnut Association accept no responsibility for decisions or actions taken as a result of any data, information, statement of advice, expressed or implied, contained in this guide.

Growers are encouraged to use their own judgement and to consider their own circumstances when making decisions.

Note: *This information is a general guide only and it is not intended to be a stand-alone tool in making key management decisions*

Contacts: this guide does not provide a full listing of service contacts for the industry. The BC Hazelnut Grower Association may be able to assist you to find the information or services required. Please visit:

<https://www.bchga.ca/>

Website references: References provided within the body of the guide and summarized in the appendix provide sources deemed useful by industry associations, government agencies or universities. Not all information provided may be applicable to the specific growing conditions of your farm.

INTRODUCTION

A hazelnut orchard offers the opportunity for a financially and personally rewarding business venture for the dedicated owner who has a sound business plan. The sector is attractive to new growers due to the small land base and graduated capital investment; however, a wide range of knowledge is required and, there are many things to be considered before investing in a hazelnut operation.

PURPOSE OF THIS GUIDE

This booklet is intended to assist a new grower in making the decision of whether to enter the hazelnut or hard nut sector. The publication gives an overview of the sector, discusses points that should be considered before starting a hazelnut orchard, and offers other valuable sources of information.

BACKGROUND

Hazelnuts are a species of tree in the *Corylus* family and are often referred to as filberts. There are several native species in North America but the European hazelnut (*Corylus avellana* L.) is the primary species grown for commercial purpose. Most of the production in North America is based in Oregon, while Turkey is the major producer worldwide. In BC, commercial production of European and hybrid cultivars is centred in the eastern

Fraser Valley, mainly around Chilliwack and Agassiz, though there are orchards scattered in the southern Interior and on Vancouver Island.

Hazelnuts are a deciduous large shrub or small tree and their height characteristics are dependent on the species and variety. The European and hybrid varieties that are normally grown in orchard settings are trained as a small tree usually averaging 4.5 -7 m in height. The hazelnut itself is a small brown oval nut that varies in size depending on the particular variety. Hazelnuts grow in clusters of one to six nuts, each covered by a shell and a husk that encases the nut. When the nut is ripe, the husk of some species and varieties releases the nut while in others the husk must be picked and mechanically separated from the nuts. The kernel of the nut is edible and used raw or roasted and as an ingredient in many commercial, baked and culinary products.

HAZELNUT BIOLOGY

The publication "Growing hazelnuts in the Pacific Northwest: pollination and nut development" Oregon: (<https://catalog.extension.oregonstate.edu/em9074/html>) provides an excellent botanical overview and explains why a hazelnut orchard must be carefully designed. It discusses which varieties to choose to maximize production.

Hazelnut harvesting is normally done in October on the coast. Fresh nuts are washed, dried and size graded in preparation for marketing. For nuts to keep well, they should be dried to about 10% moisture content and stored in a cool dry location.

PLANNING CONSIDERATIONS

Proper planning of a hazelnut orchard is essential to maximise a site's management and production potential. Some considerations are:

- crops growing in adjacent fields
- locations of neighbouring private residences or public buildings
- location of underlying tile drains and outlets
- direction of water flow
- soil profile and composition
- topography
- areas of concern (water pooling areas, outcropping obstacles, easements, etc.)

PRODUCTION CONSIDERATIONS

Commercial hazelnuts prefer a rich, light, well-drained soil, but plants can tolerate a wider range of conditions. Some hazelnut varieties have shown good growth on heavy clays, silt loams, and sandy loams. Management will be dependent on the type of hazelnut being grown: the standard European species that is trained as a tree, or the hybrid that has a bush form. Trees require pruning for best production. Hazelnuts are wind-pollinated and planting design must take this into account. Fertilization should be based on soil tests. In BC, tree hazelnuts are susceptible to Eastern Filbert Blight, a serious disease, while bush hazelnuts carry some resistance or tolerance to the blight.

TOPOGRAPHICAL CONSIDERATIONS

A hazelnut orchard is ideally planted on level ground, for ease of machinery use when harvesting. If the site has low areas, frost may damage flowers and vegetative growth.

SOIL TYPE

Commercial hazelnuts prefer a rich, light, well-drained soil, although plants can tolerate a wide range of conditions. The best growing conditions for hazelnuts are:

- well-drained, deep (minimum 1.5-3.0 metres depth), fertile, moist loam to sandy loam, with profuse aeration.
- soil pH between 6-7.
- heavier soils will need adequate drainage.
- sandy or coarse soils will reduce productivity in non-irrigated orchards.

Oregon: <https://catalog.extension.oregonstate.edu/em9076>

WATER QUALITY & QUANTITY

Selecting a location with an appropriate quality and quantity of water is important as irrigation of the orchard will result in increased plant health. Always collect and analyse site or source water to determine the pH, salinity and other nutrients prior to use. Ensuring the water source is plentiful enough to maintain the determined irrigation requirements for the specific field is necessary, as summers in British Columbia can bring drought and other complications with field management.

Note: In BC groundwater registration is mandatory as of 2016 and any water withdrawals from surface water must be licenced. (<https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-licensing-rights/water-licences-approvals>)

LIGHT REQUIREMENTS

Although hazelnuts will tolerate considerable amounts of shade, nut production will only reach its potential in full sun. Some hazelnut varieties are quite drought tolerant once established. Hazelnuts are reasonably successful competitors, but without adequate weed control, growth will be significantly slowed. Hazelnut plants do not appear to be a highly valued deer browse.

Oregon: <https://catalog.extension.oregonstate.edu/em9077>
<https://catalog.extension.oregonstate.edu/em9076>

WIND PROTECTION

Because hazelnuts are wind-pollinated, they require some air movement to transfer pollen. However, the canopy and developing crop are sensitive to damage by strong winds. Hazelnut plantings, like all horticultural crops, benefit with shelter from damaging winds. Some areas in British Columbia could benefit from wind protection such as windbreaks as in some locations exposed male catkin flowers can be damaged during cold dry winter months. Most of the Fraser Valley locations are not in need of such an installation.

AIR DRAINAGE

For areas of British Columbia that have hilled topography for orchards, such as the Okanagan and Vancouver Island, air drainage will be a factor. The most substantial issue is the risk of late spring frosts in low-lying areas of an orchard which can result in damage to expanding buds and newly emerged shoots. Care must be taking to

plan an orchard with a range of varieties that have different dormancy characteristics to help protect the grower's investment and orchard productivity.

PROXIMITY TO FORESTED AREAS

Although natural forested areas promote a healthy environment, hazelnut orchards are often affected by insect pests and diseases commonly found in forests. Where new hazelnut orchards are established close to forested areas, monitor the health of the orchard and identify any symptoms of diseases and insect pests. Some species and mammals like squirrels, deer and raccoons can consume considerable quantities of hazelnuts that are near ripe.

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

INTERCROPPING

Hazelnuts have a wide range of potential applications in intercropping systems, depending on the varieties chosen. Hazelnuts can provide a windbreak that allows a landowner to generate some income directly from the windbreak. The challenge in using standard European varieties in intercropping systems is that mechanized harvesting requires clean cultivation under trees.

Oregon: <https://catalog.extension.oregonstate.edu/topic/agriculture/hazelnut-production>

Refer to the Agroforestry Production Development Tool from UBC (APD Tool) to better anticipate costs, revenues, challenges and benefits of an intercropping system with hazelnuts:

http://agroforestry.ubcfarm.ubc.ca/files/2013/03/APD-TOOL_Alley-Cropping_UBC-Farm1.xlsm

The tool comes with supporting documentation and a tutorial video: <https://www.youtube.com/watch?v=-adyiO4kKGg&feature=youtu.be>

HARVESTING CONSIDERATIONS

Commercial harvesting is normally a highly mechanized operation with two main steps. First, the ripe nuts that have fallen to the ground are swept or blown into a windrow (a long continuous row) between the rows of trees. A second machine then follows to scoop up the nuts, while a large fan blows away any unwanted debris. For efficiency, the area under the trees is carefully flattened and kept clean, often with the use of herbicides.

Oregon: <https://catalog.extension.oregonstate.edu/em9079>

MARKET CONSIDERATIONS

In 2016, annual world hazelnut production was approximately 773,000 metric tons (slightly higher than almonds). Turkey is the largest producer with 71 % of the world market followed by North America with 5 %, Europe is the largest consumer market followed by Asia and North America. Most shelled hazelnuts are processed into confectionary and nut spreads. Nuts are also sold in the shell for the Christmas market, as a component of mixed nuts, processed into hazel butter, as well as into a premium salad oil. The potential for new processed products and broader market development appears to be high. Small growers can maximize returns through direct sales or, if possible, by considering value-added products. At present, all hazelnuts in the world market come from the European species and its varieties.

The main area of production in North America is Oregon with 95% of commercial production and located in the Willamette Valley region. Until recently, the major disease pathogen on North American hazelnuts, Eastern Filbert Blight (EFB), was not present in Oregon orchards. Unfortunately, EFB is now established in the Pacific

Northwest so in response, there is a very active breeding program at Oregon State University and they have developed a number of high producing varieties that demonstrate medium to high levels of tolerance to the disease.

In British Columbia, hazelnuts are the only nut crop produced commercially in BC although walnuts and sweet chestnuts are grown in a few orchards located in the southern regions of the province. Currently, there are about 40 BC hazelnut growers and they are located primarily in the Fraser Valley.

Past production is noted in the table below and pricing is set based off Oregon prices. Production is shown in the table below (Table 1) (2006-2013)

Table 1- BC Hazelnut Production (2006-13)

Year	Conventional (lbs)	% Total	Organic (lbs)	% Total	Total (lbs)
2006	835,318	71.4	335,032	28.6	1,170,350
2007	721,182	74.8	243,434	25.2	964,616
2008	530,400	67.5	255,860	32.5	786,260
2009	868,265	79.4	224,760	20.6	1,093,025
2010	891,604	81.9	196,489	18.1	1,088,093
2011	546,000	72.6	206,306	27.4	752,306
2012	370,000	83.5	73,100	16.5	443,100
2013	850,100	77.3	250,200	22.7	1,100,300

The industry is now in the process of a major renewal due to the impacts of Eastern Filbert Blight (EFB). Production should increase in coming years as newer plantings enter full production. A 2017 survey identified a total of 973 acres of hazelnut production divided into the following five categories: Active (285.5 acres); Replanted (137 acres); Abandoned (49 acres); and Removed (502 acres) (BCAGRI-ES Cropconsult, 2018).

The industry is served by one processing facility in the Fraser Valley which is part of the supply chain for Oregon processors. A large portion of this production is exported to Oregon by truck and a smaller portion of the production is sold locally as value-added products (such as hazelnut butter and candy products). In addition, new markets are beginning to develop as numerous consumer niche markets are seeking healthy nut-based food products.

MANAGEMENT CONSIDERATIONS/NEW GROWERS

CONSIDERATIONS FOR NEW GROWERS

A hazelnut orchard must be operated as business with good crop and financial management coupled with accurate recordkeeping. A strong focus on quality assurance through the entire production and processing phases is required if you wish to maximize returns on your investment.

There are many points to consider when looking at starting a hazelnut orchard, such as:

- personal aptitude,
- marketing,
- site selection,
- site design and layout,
- developing a business plan, and
- variety selection.

Each of these points is covered in the following sections.

In addition, there are regional considerations when producing hazelnuts in BC:

- Market development opportunities are needed.
- BC market –nuts for cracking are shipped to Oregon and returned.
- High cost of land in relation to value of the crop.
- BC has mainly part-time hazelnut farmers on smaller farms.
- Need higher-yielding varieties that have resistance to EFB.
- Restrictions by CFIA on the import of cuttings of EFB resistant hazelnut varieties to BC.
- Limited supply of resistant varieties within BC: 1-2-year lead time required.
- Wet weather during harvest.

PERSONAL APTITUDE

To be successful, a grower must possess a high level of commitment and have a broad range of skills. In order to reduce expenses, it is beneficial for the orchardist to be able to perform all, or most, of the work required in the day-to-day operation of the business. The skills required to operate a hazelnut orchard include:

- technical trade skills, such as plumbing, electrical, carpentry, welding, and mechanics.
- knowledge in hazelnut production, including plant growth and development, soils, plant nutrition, and pest management.
- business skills, such as record keeping, inventory control, business and personnel management, marketing, and accounting; and
- the ability to cope with adversity is invaluable, since adversity is inevitable. Adversity will arise in the form of weather or pest-related crop problems, equipment breakdowns, staff problems, and poor sales and cash flow.

The more of these skills a grower has, the better their chance of success. However, do not be discouraged if you do not possess all the skills listed, since they can be learned from courses offered by local educational institutions. There are seminars offered during the year that may be of interest to new growers. Information on these events is available through the B.C. Hazelnut Growers Association (BCHGA).

As your orchard grows in size, there will be the opportunity to hire staff with specialized skills. Until that day, the orchardist will truly need to be a “Jack-of-all-trades”.

MARKETING

There are many factors to consider when it comes to marketing. What marketing channels will work best for your situation, and what type of marketing and promotional tools will you use? What will be your market area? Will it include local, domestic or export markets? Shipping product outside your local community increases market size, but it also brings with it the need to know and adhere to regulations designed to prevent the movement of quarantine pests.

Wholesale versus Retail: There are markets for hazelnuts crops, including commercial wholesalers and processors, farm markets, niche market processors, other growers, brokers, and homeowners.

Brokering is a small but useful market channel for new growers that have a limited product line, insufficient market contacts, and/or poor marketing skills. Brokers or wholesalers enter into agreements with growers to market and sell their product for an agreed upon price.

Direct selling of product to the consumer or niche processors is attractive because it maximizes price. However, the costs associated with selling the nuts are higher.

Websites can bring the world marketplace to the door of even the smallest business at a reasonable cost. You may register a web domain by conducting an Internet search for web domain registration companies. Professional website design consultants will create a site that effectively showcases your products. If you have Internet sales outside of Canada, there are costs to meet export requirements.

It is important to investigate these issues before starting a business with a marketing program.

INITIAL OBJECTIVES AND PRIORITIES

It is important at the planning stage to rank management objectives according to your land-use priorities (low, medium, high). Remember that these objectives are a starting point, and you can (and probably will) modify them later. So if possible, numerically rank the top five objectives for your hazelnut orchard.

Objectives	Priorities			
	Low	Med	High	Top 5
<ul style="list-style-type: none"> • A new source of income from unproductive land • Reduce costs of current farm operation • Develop new source of long-term income (i.e., hazelnuts) • Increase short-term income while awaiting long-term income • Reduce land taxes • Increase intercropping or other production opportunities • Undertake environmental improvements. • Production or management considerations: hazel nut biology, site and infrastructure requirements. 				

PRODUCTION ACTIVITIES, COSTS AND MANAGEMENT

The expanding market for BC hazelnuts provides a career opportunity in farming. Advances in breeding improved and disease resistant varieties and production technology have opened new possibilities, allowing for efficient use of smaller lots, increased crop production and better pest management options. Yet with all business endeavors, potential hazelnut producers must have the right skills and knowledge to accomplish a wide range of activities from hands-on work in the field, to repairing equipment, solving problems, financial planning and management while analyzing the sector's production, market, and sales data.

If you are interested in exploring the idea of starting a hazelnut farm, there are many questions to answer. How will you gain the right knowledge? Where will you find affordable farmland? How will you finance your new farm start-up? There are numerous websites and institutions that offer a multitude of resources from production information to financial and business management. The BC Hazelnut Grower's Association

(<https://www.bchga.ca/>) and BC Ministry of Agriculture

(<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/business-market-development/agrifood-business-management>) maintain active websites with a range of farm business tools, information and

production guides and workbooks that will help to assess a potential producer's skills and interests, and ask the right questions to develop a business plan.

In addition, there are several programs and services available to assist new farmers in starting or improving their business venture, including advisory services, workshops, seminars, crop insurance and analytical tools. Most of these can be found on the BC Ministry of Agriculture website

(<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/business-market-development/agrifood-business-management/starting-a-new-farm>).

COSTS OF PRODUCTION

Hazelnuts begin bearing at three to five years of age, although full production generally starts some five to seven years later. In general, mature trees can produce 8 to 10 kg of nuts annually.

A cost of production for a 10 acres hazelnut orchard in the Fraser Valley can be found at:

https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/farm-management/farm-business-management/enterprise-budgets/hazelnut-2017_sh_august_2018.pdf

For general financial information and helpful provincial farm business programs, the BC Hazelnut Grower's Association (<https://bchga.ca/>) and BC Ministry of Agriculture

(<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/business-market-development/agrifood-business-management>) websites can provide new growers with useful examples and initiatives to support a new enterprise.

VARIETIES

Because hazelnuts are a long-term crop, selection of a main variety and its pollinizers are key and essential to a successful orchard. The timing of bloom must be matched between the main variety and the pollinizer variety. Ideal nut characteristics for the intended market must be considered. In BC, new resistant/tolerant varieties may be in short supply when an entire industry is replanting. Limited stock of disease tolerant varieties means growers may need to order plants 1-2 years in advance of orchard establishment.

Field trials are ongoing to evaluate new varieties from Oregon (resistant or tolerant to EFB). The Oregon State University Extension Services website maintains a full description of these new varieties:

<https://catalog.extension.oregonstate.edu/em9073>

The latest results of the BC variety field trials may be found on the BC Hazelnut Association website (<https://bchga.ca/>)

When choosing a hazelnut variety, consider the following factors:

- the intended market – large fruit vs small fruit, quality of kernels
- resistance or tolerance to Eastern Filbert Blight (EFB)
- winter hardiness of the wood and catkins
- harvesting dates

When choosing a pollinizer, consider the additional following factors:

- flowering characteristics –time of bloom and compatibility with main variety
- disease tolerance
- crop usage – in-shell or kernel market? A pollinizer should match the characteristics of the main variety, or it should be a distinctly different size for ease of separation
- availability of planting stock.

- pollinizers should also be good nut producers to contribute to the total crop yield.

Oregon: <https://catalog.extension.oregonstate.edu/em9074/html>

Note: *Hazelnuts are self-incompatible, i.e., they will not set nuts with their own pollen. They are monoecious, which means they have separate male and female flowers on the same tree.*

Additional considerations when determining variety selection for hazelnuts:

- Check reliable information sources for any field trials of new varieties. Based on information available, identify the new varieties that yield the best performance and productivity.
 - Analyse these varieties for any tree or nut characteristics that may affect performance and intended market requirements.
 - Look for additional opinions from local growers, consultants and nursery tree suppliers. Also check if your intended processor has any specific variety preferences for processing and marketing.
 - Identify those varieties that suit your proposed tree spacing and management system, as an example, upright varieties are necessary for close-planted orchards. This data is listed in table 2 (Growth habit/tree size vigor)
 - Select as many varieties as is appropriate to effectively spread the risk and harvesting workload. Nut drop periods, which determine approximately harvest times, are listed on table (Approx. harvest day). Arrangement of varieties in the orchard or orchard design may influence the number of finally chosen varieties; see Orchard design section before completing your selection.
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Note: *Variety performance can vary significantly depending on environment, soils and management and thus it is difficult to accurately predict how a variety will perform in a new orchard. Yield performance in a properly managed field variety trial in the area is one of the main features used in selecting varieties in BC. Also, other varieties from Oregon (not listed here) may be available in BC. Check with your nursery or supplier.*

LIST OF VARIETIES

Table 2: Tree orchard, Nut and kernel Characteristics of some Hazelnut Varieties

Variety	Tree and Orchard Characteristics of Hazelnut Varieties			Nut and Kernel Characteristics of Hazelnut Varieties						
	Growth habit/Tree size-vigor ¹ (%)	Cumulative yield ² /yield efficiency ³	Approx. harvest day	Nut wt. (grams)	Kernel ⁴ (%)	Nut shape	Grade size	Blanching ⁵	Good nut (%)	Kernel fiber
Barcelona (Standard)	Upright/100	Medium/medium	October 10-21*	3.3 - 3.8	39-43	Round	Medium to large	4-5	70-85	3
Clark	Upright/70	High/medium	7 days before*	2.5 - 2.8	4-8-51	Round	Small	16-33	69-81	2
Dorris	Moderate spreading/60	Medium/high	Up to 3 days before or after*	3.4	43	Round	Medium	2.4-2.9	79-81	2.0
Jefferson	Upright/70	Medium/High	Up to 3 days before or after*	3.7	45	Round	Medium	4-5	76-84	3.0
Lewis	Moderate upright/ 75	High/high	5-7 days before*	2.7 - 2.9	46-48	Round	Small	4-5	83-90	1-2
McDonald ⁶	Upright spreading	Medium/high	12-14 days before*	2.4-2.7	52	Round	Small	3.8	83-88	2.6
Sacajawea	Upright spreading/85	High/high	10-15 days before*	3	48-50	Round	Small	2.5-3.5	84	1
Yamhill	Moderate spreading/60-70	High/high	7-10 days before*	2.3	49	Round	Small	4.4-5.0	75-91	2.5
Wepster	Upright/80-110	High/high	7-10 days before*	2.4	46	Round	Small	3.0	80	2.5
<u>Felix</u>	Upright/ 100+	Low/low	7-10 days before*	2.5	50	Round	Small	1.8	95	3.0
<u>York</u>	Moderate spreading/ 75	Medium/medium		2.8	44	Round	Small	4.4-4.8	81-84	3.0
<u>Eta</u>	Upright/ 75	Medium/low		2.8	48	Round	Small	3.0	75	3.5
<u>Theta</u>	Upright/ 100	Low/low	Up to 5 days after*	2.3	50	Round	Small	2.5	85-93	2.5
<u>Gamma</u>	Upright spreading/ 100+	Medium/medium	7-10 days before*	2.5	52	Round	Small	6.0	80	3.0

Note: Shaded rows indicate varieties released as pollinizers. * Varieties are comparable to the Barcelona Standard of October 10-21st

Note that Sacajawea⁶ has a level of quantitative resistance, it does not have the complete resistance to EFB and is not recommended for areas with high disease pressure. Source: EM 8914-E August 2006 (15) (PDF) 'Sacajawea' hazelnut. Available from: https://www.researchgate.net/publication/289771109_%27Sacajawea%27_hazelnut [accessed Jun 04 2020]. Lewis also has quantitative resistance to EFB

1 As compared to the trunk cross-sectional area (TCSA) of Barcelona. TCSA is an indirect measure of tree size

4 Percentage of nut weight that is from the kernel

2 Sum of all yields to date in a given year.

5 Scale is 1-7, with 1 = 100% removal of the pellicle and 7 = no pellicle removal after roasting at

3 Yield efficiency is a function of yield and tree size. Most new varieties produce more nuts on a smaller tree than the Barcelona standard.

266°F - 302°F (130°C -150°C) for 15 minutes

Source Growing Hazelnuts in the Pacific Northwest. Hazelnut Varieties. (Table 1 to 4). <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9073.pdf>

6-Source: "McDonald" Hazelnut. <https://journals.ashs.org/hortsci/view/journals/hortsci/51/6/article-p757.xml> (accessed June 5, 2020)

Please note that other varieties from Oregon State University (not listed here) may be available in BC. Check with your nursery.

RECOMMENDED POLLINIZERS

Table 3: Compatibility of Hazelnut varieties with the Gasaway gene for resistance to Eastern Filbert Blight-Recommended pollinizers.

Female parent ² (alleles Expressed in female flowers)	Pollen source ¹ (alleles expressed in pollen)									
	Yamhill (8)	Dorris (1, 12)	Gamma* (10)	Sacajewa~ (1)	Wepster (1)	Jefferson (3)	York* (21)	Felix* (15, 21)	Eta* (11, 26)	Theta* (5, 15)
Sacajewa~ (1, 22)	+M						+L			
Yamhill (8, 26)			+M		+L	+M-L	+L			
Wepster (1,2)	+E		+M				+M	+L		
Dorris (1, 12)	+E						+E	+L		
Jefferson (1, 3)							+E	+M	+M-L	+L
Gamma* (2, 10)	+E-M			+E	+M-L	+M	+M	+L		
York* (2, 21)	+E	+E-M	+M	+E-M	+L	+L				
Felix* (15, 21)	+E	+M	+M	+M	+M-L	+L				
Eta* (11, 26)					+E	+E	+M	+L		
Theta* (5, 15)						+E			+M	

*Recommended pollinizers are indicated in a shadow rows (grey color). They should be planted as a pollinizer only, not for main crop production.

Note: + symbol indicates a compatible cross. Letters indicate the time of pollen shed relative to bloom of the female parent (E=early, M=mid, L=late)
Nuts will not set when either off the alleles in the female flower matches either of the alleles in the pollen.

1- Pollen source varieties are listed in order of earliest to latest pollen shed by calendar date.
2- Female parent varieties are listed in order of earliest to latest female bloom.

~ Sacajewea has quantitative resistance, which means it does not have the EFB resistance gene but does have some resistance to EFB infection. Scouting and spraying for EFB infections are still required.

Source: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9073.pdf>

Please note that other varieties from Oregon State University (not listed here) may be available in BC. Check with your nursery.

PLANTING STOCK

Currently, in Canada there is an import ban on trees or cuttings from the United States. Tissue culture produced plants are exempt. At the time of printing, this phytosanitary requirement is maintained by the Canadian Food Inspection Agency and is under review. It is advisable to check with the BC Hazelnut Association on a regular basis as to the status of the review and with the Hazelnut tree nurseries (list below)

CFIA Directive: *D-00-03: Import requirements from the United States and domestic movement requirements for material to prevent the introduction of Eastern filbert blight into British Columbia*

(<http://epe.lac-bac.gc.ca/100/206/301/cfia-acia/2011-09-21/www.inspection.gc.ca/english/plaveg/protect/dir/d-00-03e.shtml>)

HAZELNUT TREE NURSERY

Nurseries

Mosterman Plants Inc.
 Contact person: Sylvia Mosterman
 Website: <http://mostplantsinc.com/>
 Mail address: 43583 Adams Rd. Chilliwack, BC V2R 4L1
 Email: mostplantsinc@shaw.ca
 Phone: 604 823 4713

Mountain View Acres
 Contact person: Neil TeBrinke
 Email: neiltb@hotmail.com
 Phone: 604 796 3437

Nature Tech Nursery LTD.
 Contact person: Thom O'Dell
 Website: <https://www.naturetechnursery.com/>
 Email: info@naturetechnursery.com

Pacific Coast Agriculture
 Chilliwack, BC
 Email: info@pcagriculture.ca
 Phone: 604 798 2798

- **Processing Facility**

Fraser Valley Hazelnuts LTD.
 Contact person: Kevin Hooge or Don Hooge
 Email: kevin@fraservalleyhazelnuts.com
 Phone: 604 997 7811 (Kevin)/ 604 793 3064 (Don)

ORCHARD DESIGN

SITE PREPARATION - PLANTING YEAR

Following the determination that the land is suitable for hazelnut production; logistical and infrastructure considerations should include but not limited to:

- road access to the property
- perimeter infrastructure and security (i.e., fencing, gates)
- type and measurement considerations for any drawn equipment such as applicators, mowers and harvesters.
- harvest direction
- tractor or machinery turning radius between rows and at the headland
- irrigation infrastructure, placement, access, and storage
- building placement and orientation for ease of access, power, and expansion potential
- storage and waste locations with disposal options
- inter-cropping considerations and requirements

SOIL MANAGEMENT

Preparing the land for planting should include:

- levelling of the land to a relatively even surface with little compaction
- drainage and irrigation installation
- gravel/rock removal
- weed management through cultivation and herbicide application in the season before planting. Care must be exercised to not plant into soils with recent applications of residual herbicides.
- additional soil amendments based on soil test results
- ground cover to prevent soil erosion and reduce weed competition
- inter-row considerations preparation for an alternate crop while hazelnut trees are growing to first harvest

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/soil-nutrients/management>

DRAINAGE

In high rainfall areas or low-lying acreages, drainage is fundamental to removing excess water from the soil. For hazelnuts, surface roots may take up moisture from top levels of the soil but if not properly drained. Lower roots may encounter extended periods of waterlogging which will reduce tree health and productivity. At the planning stage, the soil profile of the orchard should be determined, and soil composition tested prior to planting. Depending on these investigations and in locations where natural drainage of soil moisture is not adequate, additional drainage, such as tile drainage, may need to be installed prior to planting. Hazelnut orchards located on deep sand or gravel-sand soil on high ground may not need tile drainage installed before the orchard is planted.

To provide adequate drainage of orchards, space perforated tiles need to be located 9-12 m between parallel drains in sandy to sand-loam soil, and 7.5-9 m between tiles on heavier soil. The tiles should be

approximately 1-1.5 m deep to help maintain the water table at or below this depth. Tile drainage at this spacing will drain excess soil water from the orchard quickly and prevent flooding injury to hazelnut root systems. Consult with a local drainage specialist for specifics in your region.

Ontario: <http://www.omafra.gov.on.ca/english/engineer/facts/10-091.htm>.

IRRIGATION

Hazelnut trees obtain moisture from the upper soil layer (top 60 cm) more rapidly than the lower regions of the soil. Established hazelnut trees will tolerate relatively dry soils, but growers in BC have noted a larger percentage of empty nut shells following extended periods of dry weather, significantly reducing crop yield. Irrigation can help offset the effects of extended period of dry weather.

The two most used irrigation systems are:

- Trickle tape or drip irrigation: uses less water, efficiently wets the root zone depth, and it is generally cheaper to install but must be properly maintained to prevent blockages.
- Under tree mini-sprinklers with a micro spray or micro-jet feature

Irrigation systems should be designed and installed prior to plant establishment. A custom irrigation plan, specific to the grower's water requirements, water source, and quality of materials, automation and budget can be created with the assistance of an irrigation company. Irrigation lines should be easily accessible, monitored and maintained to ensure the proper distribution and apportioning of water through the growing season. Some orchards have installed on-farm weather stations that are helpful in automating the irrigation frequency.

Note: Consult with irrigation companies for advice on how to set up irrigation systems for hazelnut orchards

PLANT SPACING

Plant spacing is crucial to the productivity, maintenance, and renovation of an orchard over time. Appropriate plant spacing depends on the site characteristics (topography, soil type and quality, drainage, site microclimates), inputs of water, fertilizer and pesticides, the hazelnut varieties selected, and the location of the trees designated to be pollinizers.

Trees should be planted and spaced in north to south rows for better sun exposure into the canopy.

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9077.pdf>.

Common plant spacings:

1. TRADITIONAL:

Trees are spaced 6 x 6 m (267 trees/ hectare) to 5.5 x 5.5 m (331 trees/ hectare). These spacings generally allow for large plants and possibly multiple stems. These are solid permanent spacings for most soil types and hazelnut varieties.

2. DOUBLE DENSITY

Trees are spaced 3 x 6 m (538 trees/ hectare) or 3.6 x 5.5 meters with 496 trees per hectare, with thinning to a triangle of about 6, 6.4, or 6.7 meters. The extra trees or "interplants" are only temporary at establishment and are thinned after 8-12 years to increase the space for maturing trees to maintain productivity. The production/ tree in a high-density orchard is nearly the same as that from a traditional-density orchard for the first 5-6 years, as the yield per hectare increases in proportion to the higher number of trees. The interplants should never be the pollinizer variety as they will be thinned out over time within the orchard. Spacing should be in a zigzag pattern to give trees the optimal space (i.e., two parallel rows are planted half the planting distance in row offset).

POLLINIZERS

Hazelnuts are wind pollinated and require well matched pollinizer varieties distributed effectively throughout the orchard so that pollen is available when the female flowers open. Oregon State researchers suggest at least three pollinizer varieties (early, mid, and late pollen release). Pollinizers are planted in permanent spaces only, and the percentage of pollinizer trees is calculated based on permanent spaces only. Pollinizers should be alternated by rows, on a diagonal or some other pattern that spreads each variety throughout the orchard. A typical pollinizer planting is every third permanent tree, every third row. The planting of at least three different pollen sources within the orchard is recommended.

See table 3: [Compatibility of Hazelnut varieties with the Gasaway gene for resistance to Eastern Filbert Blight-Recommended pollinizers in the Introduction section.](#)

PLANTING METHODS

Hazelnut trees should be planted in the fall or late winter/early spring, depending on the region of BC. They should be planted no deeper than they were planted in the nursery or in the pot. If planted more than 2.5 cm deeper than in the pot, the following year's growth will be stunted while the tree grows its roots towards the surface. There is a marked color difference on the trunk and this habit may become permanent and also lead to infections below the soil surface.

Plant the tree in a hole that is 46 – 61 cm in diameter, and 25-30 cm in depth. Create a mound of soil at the bottom of the hole to support the tree, and account for settling of the plant over time.

1. PLANTING BY SHOVEL

Planting by shovel is the preferred method as it will enable the hole edges to be less compacted and allow for easier root penetration. This is especially ideal if planting conditions are wet.

2. PLANTING BY AUGER

Planting by auger tends to compact the soil edges of the hole, especially when planting in wet conditions, or when there is high clay content. An auger can smooth the sides of the hole creating a

barrier that young roots have trouble penetrating. A bolt or similar can be attached to the side of the auger blade to tear up the sides to improve root penetration.

While backfilling the hole around the tree, soil must be loosely applied while tapping it around the roots. Do not compact the soil in around the roots, as hazelnut roots need good aeration, and otherwise the roots can be compromised if planted too deeply.

ORCHARD ESTABLISHMENT

MANAGING YOUNG TREES

During the first four years, the aim is to grow a strong, well-structured tree that will produce well in future years. There are some important operations to follow:

PRUNING AND TRAINING

PRUNING

Hazelnut trees usually do not require pruning until the second year. Do not prune young trees excessively so as to avoid removing too much wood. One recommendation is to remove one-half the fruiting area from one-fifth of the trees annually, while leaving as large a branch framework as possible. Bushes can also be coppiced (cut to the ground) if the growth form or size becomes undesirable; re-growth is dependable. Prune hazelnuts in late winter and early spring before dormant buds begin to grow. Pruning during late fall may result in tree injury, where fresh large cuts can dry back to main scaffold branches before these sites heal during the following spring. In moist climate areas such as the coastal regions, this is important since pruning sites that are exposed to wetness for too long time may allow fungal or bacterial rot to establish resulting in systemic damage to the trees.

Remove all pruned cuttings from the orchard before the trees begin to grow in spring to prevent the possible spread of disease.

TRAINING

After the first growing season the process of scaffold selection can begin. The goal is to select 3 to 5 scaffold branches that are evenly spaced around the tree. Hopefully one can achieve some vertical distance between branches. Avoid selecting two branches that are emerging from the trunk at the same height. This situation would ultimately make for some weak branches, as they grow older. Also, scaffold branches should be high enough so as not to interfere with maintenance and harvesting, but not too high up to make trees top heavy.

After the scaffold branches are selected, it helps to come back the following year and support them by removing any strong competing branches. Once the scaffolds get a "head start", they usually do all right. After the scaffolds have been established, trees are generally left alone. Excessive pruning of young trees can delay or reduce their early yields. After the trees are ten years old or older, they may require more corrective pruning, depending on their vigor and spacing.

WEED MANAGEMENT

Good weed control is critical, especially in the establishment years. Weeds compete with the newly planted trees for water and nutrients. Weeds should be controlled by maintaining a grassed inter-row area with mulching along the tree rows. Mulch not only minimizes weeds, it also reduce soil moisture loss, maintains a more even soil temperature and improves the soil surface structure. Weeds that then grow through the mulch can be spot sprayed with an herbicide. The mulch should be placed around the tree 2-3 feet (60 -90 cm) away from the trunk, when the ground is still moist to retain soil moisture and help with weed control. The mulch layer should be 3-4-inch (7.5-10cm) layer.

CAUTION: Care must be taken that all obstacles including mulches, are not in the way of future harvesting machinery operation.

It is recommended to use mulches such as sawdust, wood chips, aged horse manure or any material that have high concentrations of tannins (cedar, juniper etc.). Darker materials will heat up the soil faster, promoting root development. When selecting a material, be aware that when organic materials break down, they take up nitrogen, so additional nitrogen fertilizer is suggested. Plastic mulches are not advised as they can interfere with harvesting procedures.

WARNING: before using any herbicides (pesticides) carefully read the label and follow the instructions. See table 8 with list of herbicides registered for use in Hazelnuts in the Weed Management section

IRRIGATION

Irrigation is especially important in new plantings where plants have small and shallow root system. Do not allow the root ball to dry out after planting. Irrigate (or hand water where irrigation is not installed) for the first few weeks. Once the trees are well established, use a soil moisture monitoring system to help calculate how often and how much to water.

GROUND COVER

Ground cover will help prevent erosion in the orchard, limit topsoil loss due to wind/runoff, decrease dust, as well as prevent muck fields when running machinery through. Some recommended ground covers are dwarf perennial rye, hare barley, annual ryegrass, or other grasses will work as well.

MANAGING ESTABLISHED NUT BEARING TREES

Once the trees begin to produce hazelnuts, orchard management shifts to a focus on achieving maximum productivity of quality nuts; keeping vegetative growth in balance; and maintaining a healthy root system. This requires the producer to engage in the following are important operational activities: fertilising (nutrient

management), watering (irrigation management); pruning (canopy management); weed and insect control (pest management); orchard floor management; and finally harvest.

MANAGEMENT SCHEDULE

The following is a general guide to hazelnut management based upon plant and pest development. The suggested timings will vary according to the hazelnut variety, weather, and location.

Table 4: Calendar of operational activities in hazelnut orchards

Monthly Hazelnut Orchard Maintenance Schedule												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Pruning												
Fertilizing												
Moss and Lichen												
Winter Moth-Spanworm												
Flail												
Cultivate												
Weed Control												
Sucker Control												
Foliar Boron Application												
Aphid Control												
Leafroller Control (spring and summer feeders)												
Bacterial Blight Control												
Leaf tissue analysis												
Soil analysis												
Pre-Harvest Care												
Harvesting												
Management												
Eastern Filbert Blight												

NUTRIENT MANAGEMENT

Maintaining the correct amounts of nutrients in the soil and plant are essential for ensuring optimal tree growth and yield. Therefore, soil and leaf tissue analysis is necessary to monitor nutrient levels and plan fertilizer applications. Throughout British Columbia, nutrient application rates vary depending on the age and nutrient status of the orchard, variety of tree, and soil type.

Note: As new varieties are being planted in BC, more research is needed to determine the optimal leaf nutrient concentrations and fertilizer requirements for BC hazelnuts.

SAMPLING

In hazelnut production, a soil analysis is most beneficial (1) before planting to determine nutrient and lime requirements and (2) during regular intervals in established orchards to monitor pH. Soil sampling and analysis should be completed in the late spring and fall to ensure any liming materials are given sufficient time to raise soil pH.

Application of fertilizer to established orchards is based primarily on concentrations of nutrients measured by leaf tissue analysis. Sampling of hazelnut leaves for analysis should be completed in August and sent to an analytical laboratory in a timely manner.

It is recommended that soil sampling and analysis is completed at least once every two years while leaf tissue sampling and analysis should be completed annually.

Sampling procedures

- *Soil sampling*

Soil sampling and preparation instructions can be found through the BC Ministry of Agriculture publication [Soil Sampling for Nutrient Management](#) (Publication 631-500-1).

It is important that the soil sample represent the orchard. Take soil samples from under the tree canopy, but not in the area immediately around the tree's base. Where possible, avoid taking samples from locations where bands of fertilizer have been previously applied. Surface samples (0-15 cm) are generally sufficient for determining the need for liming materials.

In hazelnut orchards and other crops where nutrients and lime are consistently surface applied, the top 5 cm (2 in) of soil may be significantly more acidic than the rest of the soil rooting zone after several years of surface applications. Therefore, soil from the top 5 cm of a soil sample should be separated and analysed separately from the remainder of the soil sample to determine the effect of surface applications. More information can be found in [OSU Publication EM 9014](#).

- *Leaf tissue*

Leaf tissue samples should be taken from at least 10 trees that are representative of the orchard every August. If some trees have visual nutrient deficiency symptoms or reduced yield, then they should be sampled separately. Sample fully developed leaves that are:

- Near the outside of the tree
- About head height
- In the middle of the current season's shoot growth

The petiole (leaf stem) should remain with the leaf. Take at least 5 leaf samples per tree. If more samples are taken on one tree, each sampled tree should have the same number of leaf samples taken.

A list of analytical laboratories for soil and leaf tissue testing can be found through the BC Ministry of Agriculture publication [Nutrient Testing Laboratories](#) (Publication 631-500-8).

LIMING SOILS

Lime should be applied if the soil pH is 5.6 or below. Liming acid soils will make phosphorus, potassium, magnesium, and some micronutrients more available to the trees and is a source of calcium. It will also provide

magnesium if dolomitic limestone is used. Soil tests can determine if a lime application is necessary and how much lime to add per acre if an analysis of the soil's Lime Buffer Capacity (LBC) is requested. It is recommended to incorporate lime into the soil root zone several weeks before planting. If lime needs to be applied to an established orchard, it should be applied in the fall to allow for movement into the soil profile and neutralization of soil acidity before the next cropping season.

FERTILIZATION

Critical values for nutrients in hazelnut leaf tissue can be found in [OSU Extension Publication EM 9080](#). Leaf tissue concentrations should be monitored to re-evaluate the nutrient status of the tree and plan future nutrient applications.

In mature orchards, many nutrient applications are applied in a band. Banded applications of fertilizer should be placed just within the tree's dripline to ensure proper uptake.

- *Nitrogen*

Nitrogen (N) should not be applied in the first year after planting. Up to one-eighth lb N/tree can be applied in the second year as temperature-release fertilizer to avoid burning the new root system. Until the tree is mature (10-12 years old), N fertilization should be built up to the full rate. Refer to the below table for guidance on N fertilization of young trees:

Age (year)	N fertilization (lb./tree)
0-1	0
2	0.125 (only as temperature-release fertilizer)
3-5	0.25-0.33
6-7	0.33-0.5
8-10	0.50-0.75

Once trees have reached maturity, N rates can be increased to 1.5 to 2 lb. N/tree. If N is banded, N rates can be decreased to 1.1 to 1.6 lb. N/tree. N application should coincide with bud break, which is generally in March or April in British Columbia.

- *Phosphorus*

Many soils in the Lower Mainland are high in phosphorus (P), so care must be taken to avoid over-application. Maintaining a soil pH near 6.5 will aid in maximizing soil phosphorus availability.

- *Potassium*

Potassium (K) should be incorporated into the soil prior to orchard establishment. Using results from a soil analysis refer to the follow table to determine how much K (as K₂O) should be incorporated prior to establishment. Note that soil test K is based on the Kelowna extractant:

Soil test K (ppm)	Amount K ₂ O incorporation (lb/ac)
0-55	300-400
56-110	200-300
Over 110	0

Adapted from OSU Extension Publication EM 9080

If soil test K was determined using a different extractant, the results can be converted by following the directions described in BC Ministry of Agriculture publication [Understanding Different Soil Test Methods](#) (Publication 631.500-9).

If the leaf tissue concentration of K is below the normal range, 6-12 lb. K₂O/tree should be applied. Potassium can be applied in the fall as its mobility is limited in the soil. Applications of K should be placed in a band that is 20-30 cm (8-12 in) wide.

- *Magnesium*

Magnesium (Mg) can be incorporated into the soil before establishment as dolomitic lime. If leaf tissue analysis shows that Mg is deficient, 30-40 lb/ac of actual magnesium should be applied, generally as potassium magnesium sulphate. Epsom salts (magnesium sulphate) can also be applied at a rate of 2-4 lb. /ac. Magnesium is typically applied in the spring, concurrent with N application.

- *Boron*

Boron (B) is typically deficient in Fraser Valley soils; so many producers will apply B annually in mid-May to early June. Boron has also been shown to increase nut set in hazelnut orchards, even if B is not found to be deficient.

As a foliar application, up to 5 lb. Solubor/ac (1 lb actual B/ac) can be applied to orchards greater than five years old. If leaf B is above 200 ppm, B applications should be stopped for the following year. If B is soil applied, 5-7 lb actual B/ac should be used.

IRRIGATION

Water stress to the trees should be avoided from flowering to nut maturity. It is necessary to irrigate often in the summer (especially July and August) as upper soil layers dry quicker than deeper soil layers. Drip irrigation may be optimal while trees are young.

Soil moisture devices such as tensiometers or capacitance probes should be used to determinate when to water, and how much water to apply.

CANOPY MANAGEMENT

TREE PRUNING PRIORITIES

1- Maintain health of tree:

- Remove all dead, dying and diseased limbs
- Remove crossovers, which can rub together and damage limbs and harbor disease
- Remove hazardous branches before they fall
- Correct and repair damage

2. Raise the canopy to enable passage of machinery (sweepers/harvesters) through the orchard

3- Rejuvenate the tree by removal of old wood in such a way that encourages the formation of new wood (remove no more than 1/3 of the wood in one year)

4- Improve the aesthetic quality of the tree and thus its value

5- Slow the tree's growth by timely removal of foliage

6- Maintain nut production

- Remove limbs that grow down or straight up
- Maintain tree size
- Develop strong 45-degree angles to support nuts

TIMING

The best time to prune trees is generally during the dormant period, usually in late winter (November–March). However, pruning can be done year-round, as needed; for example, dead or diseased branches can be removed any time, the sooner the better.

When pruning trees keep this in mind: Pruning done during the dormant season tends to have an invigorating effect on tree growth. Pruning done during peak growth times tends to slow growth by removing leaves that manufacture nourishment, but too much summer pruning can damage a tree. Pruning during the spring (post-dormancy) and fall (pre-dormancy) is generally the least desirable time as the plant is most vulnerable during those times.

Sooner rather than later: When you cut away part of a plant, a wound is left, susceptible to pests and diseases. To avoid trouble always prune so as to make small wounds, rather than large ones.

Removing a bud or twig produces a smaller wound than waiting until it is a large limb! Rubbing off a sucker bud leaves a smaller wound than if you wait until it has a year's growth or more.

PRUNING MATURE TREES

Renewal pruning of trees should be done every 1-2 years to increase light and spray penetration, and to reduce the risk of fungal diseases. Perform general pruning from December to February. Remove lower branches to ensure no machinery movement difficulties arise when harvesting/sweeping.

Hazelnuts should be pruned into single stem trees to make pruning operations more efficient, to prevent ice build-up from breaking branches, and to make it easier to harvest by machine. Remember: Hazelnuts are produced on new wood, so pruning out old wood is necessary to maintain yield

TYPES OF PRUNING CUTTINGS

When pruning, be aware that hazelnuts are very susceptible to wood rot fungi. This means that the larger the size of the cut made, the higher the chances are for infection. To prevent this, keep the branch collar (the raised area at the base of each branch) intact while making the cut, as it contains specialized cells which seal off a pruning wood naturally. In coastal areas, be sure to slope cuts slightly so that water runs off when it rains. Generally, cutting straight across to limit the size of the open wound is a good practice. If cuts are greater than 2.5 cm in diameter, protect them from exposure by application of a pruning cover (spray on or paint on).

Heading (topping)

Heading is the process of cutting the tops of tall trees to a desired height, either angled or horizontally. Cutting a portion of a branch off tends to cause a flush of multiple shoots to grow below the cut. Oftentimes this regrowth is not productive- making too many heading cuts causes the growth of excessive outside foliage, which limits the tree's light exposure.

Thinning

Removing whole branches often improves light penetration, which is necessary for flower and eventually nut set. In mature trees, most cuts should be thinning type cuts. Make the cut to a lateral branch as this helps redirect the regrowth and making a healthy pruning cut.

Oregon: <https://extension.oregonstate.edu/crop-production/nuts/basic-guide-pruning-hazelnut-trees>

ORCHARD HEIGHT

In overgrown orchards, cutting off about 10-15 feet in height may be necessary. Remember to cut lateral branches that are within the range of height that should be achieved. Branches should be cut at varying heights to prevent flat tops. Overall, the goal in a rotational pruning program is to reduce the fruiting wood by half on the trees. This goal can be achieved through height reduction cuts and proper management.

ORCHARD FLOOR MANAGEMENT

The orchard floor is both a work surface for orchard operations, and an important biological zone that supports productive trees.

An ideal orchard floor would be easy to maintain, aid the growth of the trees and nuts, maintain the soil structure of the orchard, and not compete with the trees for water and nutrients nor harbor insects or other pests.

Management practices for orchard floor maintenance should be done in a timely manner during the lifetime of the orchard. Consider the soil type, slope, age of trees, irrigation and harvesting methods at the time to decide which orchard floor management system best adapts to your orchard.

Several general systems for managing orchard floors are available:

- Intercropping ([see Intercropping in Introduction section for more information](#))
- Ground cover crops ([see ground cover in Orchard Establishment section for more information](#))
- Mulches in the tree row ([see Weed Management in Orchard Establishment section for more information](#))
- Herbicide control ([see Weed Management section for more information](#))
- Flailing
- Cultivation
- Sucker control

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9079.pdf>

FLAILING

Weed management is critical to ensuring the good health of a hazelnut orchard. Weeds reduce nutrient availability, interfere with tree growth, and reduce hand-harvesting efficiency. To control weeds, a common practice is to apply herbicides down the tree row. Another method is the use of flail mowers, which help to reduce growth of weeds.

Flail Mowers

Flail mowers are used to chop vegetation down to ground level, mulch leaves & blanks and eliminate old nuts on the orchard's ground cover.

When to flail?

- Flail 30 days prior to harvest, to smooth the orchard floor and to eliminate blanks

- After harvest and about 4-6 times per season depending upon growth of ground cover

Tips:

- Only flail growth to within 0.6 cm of soil to minimize competition for moisture
- Remove vegetation, the less vegetation, the less moisture usage by weeds and more moisture available to the trees
- If you are using a cover crop and are planning to flail, plan to leave approximately 2.5 cm crop

CULTIVATION

It is sometimes desirable to cultivate and level in new orchards for one or two years before using the flail. Cultivation in orchards should start as soon as soil is dry enough to work and cultivate only enough to control weeds and never at a depth of more than 4" (10 cm). Constant tilling will reduce the macro-pores in the soil and may lead to soil compaction especially after heavy rain falls. As well that may reduce the roots of the trees which start growing into the in between row space. Prepare a level and compact orchard floor as early as possible to avoid loss of moisture. Roll the orchard floor firmly prior to harvest

SUCKER CONTROL

Suckers are shoots sent up from the base of the tree. For the first 2 years suckers can be removed by pruning in the winter. After the second year, suckers can be controlled by spraying them with an herbicide during the growing season. Spray when the suckers are six to nine inches tall (15 to 23 cm). Most orchards require three to four treatments per year.

For specific herbicides registered for use in hazelnuts see Weed Management section

PRE-HARVEST MANAGEMENT

The orchard floor needs to be prepared before nut drop to make harvesting efficient and to reduce the amount of material that might contaminate harvested nuts.

Before beginning flailing or harvesting, the orchard floor must be smooth and even:

- Remove mounds of soil around tree trunks so the sweeper can run right up to the trunk.
- Flail or mow the orchard floor low to the ground so that the ripe, fallen nuts can be easily harvested. By flailing in two directions, creating ruts is avoided. That is where proper orchard design comes in.
- Roll the orchard floor firmly to make it flatter and smoother, allowing the sweeper brushes to sweep the hazelnuts off the ground efficiently as it passes. One may still need to use a leveling device and pull a float (rectangular metal frame) to smooth the orchard floor surface before harvest to fill in small depressions in the soil that harbor harvestable nuts. Especially in wet climates there will be many dew worm bumps that need evening out and in dry climates there may be gopher holes that will swallow the harvest.

HARVEST & POST-HARVEST OPERATIONS

HARVESTING

When to Harvest

Hazelnuts should be harvested in the mature stage when they have fallen to the ground. One can shake branches lightly to encourage nuts to fall or wait for their eventual fall. If possible, gather all fallen nuts before rainy fall weather. Harvesting the crop while it is wet will lead to storage problems and compromise nut quality.

Ontario: <http://www.omafra.gov.on.ca/english/crops/facts/12-011.htm>

Sweeping

An easy way to collect hazelnuts is through sweeping. This process cleans the tree row with air blast or mechanical fingers and deposits the nuts in a narrow windrow in the center of the row. To assure efficiency, sweep only fast enough to keep ahead of the pickup machines

Machine Harvesting

Most commercially grown hazelnuts are harvested mechanically. Generally, the nut collection process or operation follows the following process:

1. The harvesting machine follows the sweeper which lifts and separates the nuts from the leaves, twigs, etc. and deposits them in a tote box or trailer. **Note:** Some growers use trailers with bottom drops that they open over drop pits.
2. The nuts are conveyed out of the pit and into bulk trucks for delivery to the cleaning and drying plants.
3. If totes are used, a third person follows on a forklift tractor to move tote boxes out of the orchard

After harvesting, nuts are sent for market-ready processing activities- including cleaning, sorting, drying and storing. After being processed, nuts are priced according to Oregon prices which are set yearly. Prices will be relative (higher or lower) to the annual supply and production conditions in the world. Small orchard farmers will sometimes sell to a farmer's market and get two to three times the processing price, but it means more direct marketing and selling costs and likely at a distance from the orchard.

Always clean and repair mechanical harvesters before use to reduce the contamination of harvested nuts. If harvesting multiple orchards, clean the machine in between to avoid the spread of diseases and weed seeds.

Note: Perhaps your processor or buyer requires the segregation of varieties. Contact them to avoid difficulties.

POST-HARVEST ACTIVITIES

Processing

Hazelnut growers in British Columbia are rarely involved in the post-harvest operations, as nuts go directly to processing after harvest and follow these steps:

- Nuts are cleaned and dehydrated before they are stored.
- Nuts are placed in long-term storage.
- Nuts are shelled and packaged to be shipped to market or secondary manufacturers.

These operations take place at a central processing facility. At these locations, various municipal, provincial and federal regulations must be met. Post-harvest operations require facilities and the end product to meet existing food safety and quality regulations

Ontario: <http://www.omafra.gov.on.ca/english/crops/facts/12-011.htm>

Post-harvest conditions

SPECIAL HANDLING/CURING	Nuts are de-husked, cleaned, washed, sanitized and dried to 5-8% moisture within 24 hours of harvest
STORAGE CONDITIONS	Relative humidity (RH): 60-65%
STORAGE TEMPERATURE	<10°C
DURATION	Temperature dependent. Cooler temperatures increase storage life

Field Management

During post-harvest, brush or flails mow the orchard to clear or pulverize any remaining nuts, twigs and branches that may attract mice and voles into the orchard. It is beneficial to keep the ground cover fairly short until late fall, as this discourages mice and voles from inhabiting the orchard during winter

Ontario: <http://www.omafra.gov.on.ca/english/crops/facts/12-011.htm>

INSECT MANAGEMENT

INSECTS

Pest management requires regular monitoring of the orchard to determine the presence and severity of pest infestations, and the timely and appropriate management control.

FOLIAGE FEEDING CATERPILLARS



Bruce Spanworm

<https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-bruce-spanworm.pdf/>



Leafroller

<https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-tree-fruit-leafrollers.pdf/>

Status in BC: Many species, most common in BC include Bruce spanworm, Winter moth, European/Filbert leafroller and Oblique banded leafroller.

Damage- Many species of fruit and nut trees, native trees and shrubs including willow, poplar, maple and alder are hosts of the various species of leafrollers and spanworms. Bud damage can occur in early spring, as well as leaf damage in spring and summer. Severe infestations can almost defoliate small trees.

Biology - Bruce spanworm and winter moth adults fly in early winter (November-December), mate and lay overwintering eggs, laid singly on twigs in early winter. Eggs hatch in March and caterpillars feed on green tissue until dropping to the soil in late May where pupation occurs. Larvae and pupae remain in the soil until late fall and winter when adults emerge.

Leafroller life cycles vary between species, but the main species overwinter as larvae or eggs, hatching and/or becoming active and feeding in the spring, when green tissue first appears. The larvae feed on leaves and buds. Leaf-rolling caterpillars will roll leaves up as they expand, using silken webbing, where they hide during the day. European or Filbert leafroller has one generation per year, with moth flight occurring in early summer (approximately June). Oblique banded leafroller has two generations per year, so can cause damage to foliage and buds in both spring and mid summer.

Monitoring- Visually examine buds and leaves for presence of larvae and feeding damage. Limb taps to dislodge larvae and cause them to drop onto a white sheet can also be used to detect larvae. Some species,

including the European/filbert leafroller and Oblique banded leafroller, can be monitored for moth flight using pheromone baited traps in summer, to estimate population and timing of flight and consequently when to expect larvae feeding in leaves.

Management- Insecticides (organic and conventional) are registered for use in tree nuts for caterpillar control. Normally in BC foliage feeding caterpillars do not reach high enough levels to warrant spraying in established large trees. However, it may be necessary in smaller trees that are not yet fully established. Additionally, naturally occurring predators and parasites of leafrollers and other caterpillars are widely present in BC and will help manage these pests.

British Columbia:

Bruce Spanworm: <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-bruce-spanworm.pdf>
 Leafroller: <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-tree-fruit-leafrollers.pdf>

Ontario: https://www.researchgate.net/publication/289539650_Hazelnuts_in_Ontario-Pests

Aphids

Status in BC: Present

Aphids can be found on the underside of hazelnut leaves and husks. There are two main aphid species of concern in hazelnuts: the filbert aphid, *Myzocallis coryli*, and, the hazelnut aphid, *Corylobium avellanae*.

Damage: Aphids suck fluids from plant cells, causing yellowing, wilting, and distortion of leaves. Honeydew is produced as excrement, which causes the growth of black sooty mould on the surface of leaves.

Biology: The filbert aphid overwinters as an egg in crevices on bark and around bud scales. Eggs hatch in the spring, and the young aphids feed on the underside of expanding leaves. Aphids mature

rapidly and give birth to live offspring allowing for large population increases in summer.

Colonies form on the undersides of leaves, with all growth stages present. There are several generations each summer. Aphid populations can increase quickly in early summer and then decline in late summer due to high heat and increased activity by natural enemies. In late summer and fall, aphids mate and lay overwintering eggs.

Identification and Monitoring: Aphids are small and green and may be winged or wingless. Monitor weekly or bi-weekly for aphids in spring on the underside of new leaves. Keep a record of the numbers found and how they change over the season.



Aphids on the underside of a hazelnut leaf
https://www.researchgate.net/publication/289539650_Hazelnuts_in_Ontario-Pests



Aphids on husks

Photo credit: Karina Sakalauskas, BCAGRI

Presence of honeydew or stickiness on leaves and black sooty mold can be recorded. In addition, record any predators and 'mummies' (parasitized aphids) you find.

Management: Excess nitrogen can encourage aphid activity; ensure fertilizer applications are suitable. Many species of predators and parasites of aphids are present in BC and help to keep these pests under control, particularly in mid and late summer. Insecticides are available for aphids, if needed.

Oregon: <https://pnwhandbooks.org/insect/nut/hazelnut/hazelnut-aphid>

Scale

Status in BC: Various species present, but not a reported production issue in BC hazelnut orchards

Damage: Scale insects have piercing-sucking mouthparts, used to suck plant fluids, which can cause unthriftiness and even death of small branches if populations are high enough. Scales produce large amounts of honeydew as excrement, which hosts the growth of black sooty mould which can further stress plants.



Scale insects on a hazelnut branch

<https://pnwhandbooks.org/node/7373/print>

Biology: Scales are tiny insects that become immobile by attaching to plants and sucking plant fluids. Scale nymphs can be small, flat, oval and mobile when they are young, and walk readily on the plant surfaces. At this mobile stage, they are called 'crawlers' and can disperse to new plants via wind, rain, irrigation, or by the movement of people and machinery. As crawlers age, they settle on the plant surface, insert their straw-like mouth, and suck plant fluids. Once settled, the scale insect no longer moves, and feeds until a scale forms, and eggs are produced under it, resulting in a new crop of crawlers.

A common type of scale is the lecanium scale (*Parthenolecanium spp.*). The 'scales' of this species look like tiny bulbous turtle shells on twig and branch surfaces. Lecanium scale overwinters as an immature scale on twigs and branches. They resume feeding in the spring, become adult females with shells and lay eggs underneath in May to June. Eggs hatch in early summer into crawlers which migrate to the undersides of leaves to feed. After 4 to 6 weeks on the leaves, the young return to the stems and twigs to feed, mate, and overwinter. There is one generation per year.

Identification and Monitoring: Scout the orchard for scales by visually inspecting stems and twigs for the bump-like scales in spring and early summer. Honeydew or stickiness on leaves and black sooty mold can also be monitored for during the summer. If scales are found, dislodge some and look for eggs and crawlers. Record your findings. If none are seen, check again in one week. Double sided tape or other adhesive or glue can be used as a trap by applying or wrapping around a few branches and then watching for crawlers to get stuck. You will need a hand lens to accurately identify presence of crawlers.

Management: Scale can be rubbed off plants by hand with a glove or toothbrush. Major infestations can be pruned off. As with aphids, avoid excessive nitrogen fertilizer or water applications, as this may encourage population increases. Late winter applications of dormant oil will help to suppress overwintering scales. Applications of summer oil or other registered insecticide at the crawler stage will help control populations. There are many parasitoids and predators of common scale insects in BC, and these generally keep pest scale populations in check.

Oregon: <https://pnwhandbooks.org/node/7373/print>

Filbertworm

Status in BC: Present, but not usually a pest issue in BC hazelnut crops. It is rare to find any during a monitoring program.



Filbertworm larvae

<https://pnwhandbooks.org/insect/nut/hazelnut/hazelnut-filbertworm>



Adult filbertworm moth

[https://pnwhandbooks.org/insect/nut/hazelnut-filbertworm](https://pnwhandbooks.org/insect/nut/hazelnut/hazelnut-filbertworm)

Damage: The larvae feed on the kernels, severely reducing nut quality and marketable yield.

Biology: The filbertworm, *Cydia latiferreana*, is a caterpillar that feeds in nuts of hazelnuts and oaks. It is a serious pest in most hazelnut-producing regions of the world. Adult moths are gray to reddish with golden bands across each forewing. After mating in the spring, female moths lay single eggs near developing nuts from June through until fall. After 8-10 days, eggs hatch and larvae enter a nut to feed, where they remain for up to 4 weeks until they are about 1 cm long. Larvae are whitish with a brown head. Exit holes in nuts bored by the larvae are evident in harvested nuts, as well as frass and webbing. Larvae overwinter on the orchard floor under leaves and other debris, about 2-5 cm deep, in a cocoon. In the spring, the larvae pupate, and the moths emerge. There is one generation per year.

Identification and Monitoring: Adults of this insect can be monitored with commercially available pheromone traps to help determine if the adults are present, if their numbers are sufficient to cause significant damage and when to expect larval presence. Traps may be ideally placed close to wild hazelnut or oak and set up by mid-May before the moths begin to fly. Suggested trap density: use four traps for the first 10 acres and one for each additional 4 acres. For smaller orchards, 1-2 traps are adequate. Place the traps in the upper third of the canopy if possible. The action threshold is 2-3 moths on average per trap per week or five moths in any one trap per week.

Management: At present there are no insecticides registered for control of filbertworm in Canada. Insecticide sprays applied for other pests such as leafrollers will help to control filbertworm if present. Optimal treatment time is in mid-July to mid-August.

Oregon: <https://pnwhandbooks.org/insect/nut/hazelnut/hazelnut-filbertworm>

Ontario: https://www.researchgate.net/publication/289539650_Hazelnuts_in_Ontario-Pests

<https://www.ontario.ca/files/2022-10/omafra-guide-to-hazelnut-production-in-ontario-en-2022-10-13.pdf>

Brown Marmorated Stink Bug

Status in BC: Brown marmorated stink bug (BMSB) is a recently established pest in BC, first detected in 2015 in the Fraser Valley and Okanagan. It is present in urban areas and rural building sites as determined by survey and public reports. In BC, this pest has been detected in hazelnut orchards and causes some nut damage mostly on field edges but not limited to field edges.

Damage Both BMSB adults and nymphs feed by inserting their mouthparts into the flesh of fruit or vegetables. Feeding punctures result in small dead areas on fruit, vegetables, and leaves. It can feed on over 100 different plant species and BMSB is known to damage nuts during development in Oregon hazelnut orchards, causing nut distortion, corking, or blanks, decreasing marketability and quality. Recent surveys of Fraser Valley hazelnut orchards (2019-2022) show that this pest is causing low levels of corking damage to nuts and the pest abundance and damage increased over the years of the survey. Corking damage indicates that bug feeding on the nuts occurred during kernel expansion and maturation (August-September)



Adult brown marmorated stink bug
<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant->

First instar nymphs with egg mass
http://www.omafr.gov.on.ca/english/crops/facts/info_bmstinkbug.htm

Corking damage to nuts from brown marmorated stink bug feeding

Biology: Adult bugs are large (13 – 17 mm long) shield shaped brown stink bugs with white banding on legs and antennae. Adults may be confused with other native brown stink bugs and western conifer seed bugs. Eggs are laid in June-July in clusters of 20-30 white round eggs, about 1 mm in diameter, on the underside of host plant leaves. Nymphs hatch throughout the summer, and feed on plants. Initially, nymphs are orange and black, but as they grow, they become mostly black with white bands on legs and antennae. Both nymphs and adults can be found together and prefer the same hosts. All are very mobile and will readily run or fly when disturbed. By late summer and fall, most of the population are adults, but some are still nymphs. Adults have the best chance of surviving the winter. BMSB aggregate in protected areas, like homes and buildings, becoming a nuisance when they accidentally are found indoors. There is one generation per year in BC.

Identification and Monitoring: Traps and lures are commercially available and can be helpful in identifying the presence of BMSB in the area. However, the efficacy of the traps is highly variable, and sometimes unreliable. Regular (every one or two weeks in summer and fall) visual field scouting for presence of bugs, eggs, and potential damage is useful for determining if bugs are in the orchard or adjacent vegetation.

Management: Predators such as spiders, ladybugs and lacewings will feed on brown marmorated stink bug eggs. An egg parasitoid, *Trissolcus japonicus*, which is very effective in controlling BMSB is now established in the USA and recently has been confirmed in the Fraser Valley and Okanagan of BC. Native North American egg parasitoids of stink bugs are not effective in controlling BMSB. Use of insecticides for control of BMSB has been challenging, as the bugs are highly mobile, and they readily move from host to host. Application of kaolin clay for suppression of leafrollers may help prevent BMSB feeding damage to nuts. If bugs are only found on the outer edge of fields, a border spray may be adequate to prevent damage to nuts.

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/tree-fruits/brown-marmorated-stink-bug>

Ontario: http://www.omafr.gov.on.ca/english/crops/facts/info_bmstinkbug.htm#1st

US: <http://www.stopbmsb.org/>

Oregon: <https://catalog.extension.oregonstate.edu/em9102>

Bud Mites

Status in BC: Present in BC, confirmed in Okanagan.

Damage: Bud mites feed within flower and leaf buds, causing buds to swell into oversized 'big buds', or blasted buds. These damaged buds dry up and fall off, and mites move to new buds. Buds may open or partially open, but will be distorted, rigid, and brittle and catkins produce little or no pollen. Hazelnut varieties differ in susceptibility to bud mite infestation.

Biology: Two species cause bud damage: *Phytoptus* or *Phytocoptella avellanae* (the filbert bud mite), the most harmful, and *Cecidophyopsis vermiformis*. Both species may be found in the same bud. Mites overwinter within the buds. In summer they move from old buds to newly formed buds and cause them to expand from late summer through winter. Mites are protected within buds most of the time.

Identification and Monitoring: Filbert bud mites are translucent, cigar-shaped, microscopic organisms. They cannot be seen with the naked eye but can be detected by the damage they cause. Monitoring can be done by searching for big buds and dissecting suspect buds to confirm presence of mites.

Management: When big buds and damage is present, begin management which includes pruning and destroying infested buds where possible.

At least two applications of sulphur or lime sulphur sprays in late winter and spring will kill exposed mites as they move from old buds to new buds. Predatory mites may help control these pest mites.

Some hazelnut varieties are more tolerant or resistant to the mites so mite presence may not result in blasted (big) buds.

Oregon: <https://pnwhandbooks.org/insect/nut/hazelnut/hazelnut-filbert-bud-mite>

True Bug: *Phylus coryli*

Status in BC: present in hazelnut orchards

Damage: This true bug is omnivorous. It does feed on hazelnut leaves, and this can be seen readily on the leaves throughout the season. *Pylus coryli* is also a predator of aphids.

Biology: *Pylus coryli* is native to Europe but is now common in southwest BC. It has at least two generations per year in BC, and either the black adults with yellow legs or the yellow nymphs can be seen throughout the season.

No management is expected to be needed for this insect.



Feeding damage to hazelnut leaf from *Phylus coryli* .

Photo credit: Siva Sabaratnam, BC Ministry of Agriculture and Food

US/Canada: <https://bugguide.net/node/view/666353/bgimage>

UK: https://www.britishbugs.org.uk/heteroptera/Miridae/phylus_coryli.html

Leafhoppers

Status in BC: Present in hazelnut orchards

Damage: Leafhoppers are widely present in BC, and several species feed on many species of plants and crops, causing characteristic speckling on leaves from adult and nymphs feeding. Leafhoppers feed by piercing plant cells and sucking the fluids out.

Biology: Depending on the species, leafhoppers may overwinter as adults or eggs. Populations increase through summer and may have 2 or more generations per year. Adults are winged, nymphs are highly mobile. Both are easily disturbed and fly or disperse readily, making it difficult to visually identify the insects in the field, or catch for further examination.

Management: May be justified in small trees if nymph populations are high and extensive speckling is evident on hazelnut leaves. Some natural biocontrol may occur, but this does not always provide adequate control.

Spider Mites

Status in BC: spider mites occur in BC hazelnut orchards, but normally do not require treatment.

Damage: spider mites feed on foliage of plants including hazelnut leaves. Mites feed on the underside of leaves, creating colonies as the population increases. Fine webbing develops in these areas. Speckling (tiny pale spots) will appear on the top side of leaves as numbers increase. Entire leaves can start to yellow if populations are high.

Biology: Spider mites have a broad host list. They are common in many BC crops. Adult female mites overwinter in the soil starting in mid-September, and then emerge in the spring and early summer to feed and establish colonies on leaves. Populations build over the summer and are exacerbated by hot dry dusty conditions.

Management: Spider mites are attacked by many native predators in BC, including predatory mites, tiny black ladybugs (*Stethorus* sp), predatory midges, pirate bugs, and others. There are several insecticides available for use in BC hazelnuts for control of spider mites, both for conventional and organic production.

Oregon: <https://pnwhandbooks.org/node/7374/print>

Table 5: Insecticides registered for use in hazelnuts. (This is a summary sheet only. Always check the Label)

Chemical name	PCPA#	Commercial Name	Chemical group	Pre-Harvest Interval (PHI)	Minimum Re-entry (REI)	Max. # of applications per season	Target Pest
<i>Insecticides</i>							
Chlorpyrifos	29984 32768 25831 30985	Warhawk 480 EC Sharpos Nufos 4E MPower Krypton	1B	14 days	4 days	3	Aphids
dimethoate	25651 9382	Cygon 480 Lagon 480 E	1B	45 days	Thinning: 34 days Hand-line irrigation: 21 days All other activities: 5 days	1	Aphids
lambda-cyhalothrin	24984 26837 33576	Matador 120 EC Warrior Labamba	3A	14 days	24 hours	max. 390mL/ha (per season)	Leafrollers, Aphids
fenpropathrin	33817	Danitol	3	7 days scouting/pruning 3 days harvesting 24 hours all other activities	7 days scouting/pruning 3 days harvesting 24 hours all other activities	1	Spider mites Codling moth
imidacloprid	24094	Admire 240 Flowable	4A	7 days	24 hours	2	Aphids, leafhoppers
sulfoxaflor	30826	Closer	4C	7 days	12 hours	2	Scale Aphids
flupyradifurone	31452	Sivanto Prime	4D	7 days	12 hours	max. 2000mL/ha (per season)	Aphids
spinetoram	28778	Delegate	5	14 days	12 hours	3	Leafrollers
afydopyropen	33266 33265	Versys Sefina	9D	7 days	12 hours	2	Filbert aphid only
<i>Bacillus thuringiensis</i> subsp. <i>kurstaki</i>	26854 32425 26508	Bioprotec CAF* Bioprotec Plus Dipel 2X DF*	11A	0 days	4 hours	--	Leafrollers
<i>Bacillus thuringiensis</i> subsp. <i>aizawai</i>	31557	XenTari WG*	11A	0 days	4 hours	--	Leafrollers
methoxyfenozide	27786	Intrepid	18	14 days	12 hours	max. 2L/ha (per season)	Leafrollers
acequinocyl	28641	Kanemite 15 SC	20B	14 days	12 hours	max. 4.1 L/ha (per season)	Spider mites
bifenazate	27925	Acramite 50DS	20D	14 days	12 hours	1	Spider mites
spirodiclofen	28051 34247	Envidor 240 SC Spiro SC	23	7 days	12 hours	1	Spider mites
spirotetramat	28953 28954	Movento 240 SC	23	7 days	12 hours	max. 1.58L/ha (per season)	Scale, Aphids

		Movento 150 OD					
chlorantraniliprole	28981 34654	Altacor Altacor MaX	28	10 days	12 hours	3	Leafrollers
cyantraniliprole	30895	Exirel	28	5 days	12 hours	4	Leafrollers
cyclaniliprole	32889 32862	Harvanta 50SL Cyclaniliprole 50SL	28	30 days	12 hours	3	Leafrollers
tetraniliprole	33711 34488	Vayego CL73507 200 SC	28	10 days	12 hours	150-300ml/ha 4 per season	Aphids, leafrollers
Potassium salts of fatty acids	31433 28146 34539	Kopa* Opal* Oleo vert	NC	0 days	12 hours	--	Aphids, scales, spider mites
mineral oil	27666 33099	Purespray Green Spray Oil 13 E SuffOil-X	NC	—	12 hours	8	Spider mites, Aphids
Kaolin	27469	Surround WP*	NC	0 days	12 hours	—	Leafrollers
canola oil	32408	Vegol Crop Oil*	NC	0 days	12 hours	--	Aphids, scales and spider mites
Chemical name	PCPA	Commercial Name	Chemical group	Pre-Harvest Interval (PHI)	Minimum Re-entry (REI)	Max. # of applications per season	Target Pest

NC Group not indicated on product label — Information not specified on product label

PCPA: Under the Pest Control Products Act (PCPA), pesticides imported into, sold or used in Canada are required to have a PCPA Registration Number. This number is listed on the product label.

*= Potentially organic. Check with your certifying body before using

¹-All uses of products containing chlorpyrifos have been cancelled in Canada. Latest date of use of this product is December 9, 2023

General Hazelnut Production and Pest Management References:

Oregon:

Hazelnut Pests and Beneficial Insects:

<https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8979.pdf>

Oregon Nut Crops:

<https://pnwhandbooks.org/sites/pnwHandbooks/files/insect/chapterpdf/nut.pdf>

Oregon Hazelnut Production Factsheets:

<https://catalog.extension.oregonstate.edu/topic/agriculture/hazelnut-production>

Ontario:

Hazelnut Production: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

Crop Protection: <http://www.omafra.gov.on.ca/english/crops/pub360/pub360E.pdf>

For more information see **AF Production Guide Supporting Documents**.

Find downloadable supporting documents featuring: Metric Tables, Pesticide Regulations and Safety, Sprayer Calibration, and Sprayer Equipment

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides>

- **Pesticides in Agriculture**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/pesticides-agriculture>

- **Integrated Pest Management**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/integrated-pest-management>

DISEASE MANAGEMENT

DISEASES

Young orchards are susceptible to diseases, including eastern filbert blight (EFB). The new hazelnut varieties resistant to EFB have been affected by stem and trunk cankers and root rot diseases, not been previously known to occur in British Columbia. Therefore, young orchards must be periodically inspected for disease symptoms and Best Management Practices must be adopted.

EASTERN FILBERT BLIGHT

Eastern filbert blight (EFB) on hazelnut is caused by the fungal pathogen *Anisogramma anomala*. Vigour and productivity decline significantly when trees are infected with this fungus, resulting in an economically unproductive orchard. EFB has become a common and serious disease in hazelnut orchards throughout the Pacific North-Western United States and British Columbia. (B.C)

Symptoms

Infected trees may show sudden dieback of twigs and branches in summer months. When closely observed, elongated, sunken cankers expanding lengthwise on branches can be seen. Dark brown to black colored spore producing structures called 'stroma' are produced within cankers in relatively straight rows lengthwise along the branch. Cankers expand from year to year and girdle the branch, resulting in branch dieback. The disease also resembles another fungal disease caused by *Eutypella cerviculata*. *Eutypella* produces similar spore producing structures; but they are smaller in size and produced on dead wood.



Black coloured stroma on EFB infected hazelnut.
Photo credit: Siva Sabaratnam, BC Ministry of Agriculture and Food.

Biology

In the spring, spores are released from stroma produced on the cankers on infected trees. Spores are spread by rain and splashing water droplets driven by wind. Young and developing shoots, during bud break to shoot elongation, are highly susceptible to new infection.

Newly infected trees do not show any symptoms for 12-15 months (latent period). In the second summer following infection, the pathogen begins to produce stroma on the cankers (an important diagnostic feature in field and laboratory). Stroma begin releasing spores the following spring. The pathogen continues to produce new stroma and releases spores as the cankers continue to expand each year.

Identification and Monitoring

Monitoring: Control of EFB will be much more effective if the disease is detected early. Scouting should be done twice a year. In late summer, look for dying branches with 'flagging' symptom (dieback). In late fall and winter, look for the cankers and stroma on the infected branches, mostly near the upper canopy. Suspicious samples can be submitted to the Plant Health Laboratory, Ministry of Agriculture and Food or other plant diagnostic laboratories for disease confirmation.

Management

Prune out any diseased branches with cankers about 2-3 feet below the site of infection (canker area) and burn diseased wood. Alternatively, infected wood can be chipped, covered with plastic film and allowed to compost. This must be done before bud-break in spring. Because initial symptoms are often found on the top of trees, it is best to use a “cherry picker” to gain better viewing during scouting for disease and for pruning out infections.

Application of preventative fungicides are essential to help prevent new infections and reduce disease incidence; particularly young orchards of new varieties must be protected from EFB and other diseases. Since new growth in the spring and early summer is highly susceptible to infection, spraying must begin soon after bud-break. A maximum of 4 applications at 10–14-day intervals, from bud-break to new shoot growth, is considered necessary to provide adequate protection. The fungicides registered for EFB are included in Table 7. It is essential to use a right sprayer to obtain adequate coverage of all new growth. Because of EFB's latent period, effectiveness of fungicides on disease control will only be evident years after application.

British Columbia: <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-easternfilbertblightss.pdf>

Oregon: <https://pnwhandbooks.org/plantdisease/host-disease/hazelnut-corylus-avellana-eastern-filbert-blight>

BACTERIAL BLIGHT

This disease is caused by the bacterium *Xanthomonas arboricola* pv. *corylina* (also called *Xanthomonas campestris* pv. *corylina*). Losses due to this disease are most commonly seen in young, establishing trees less than 6 years of age or in stressed trees. Bacterial blight has not been observed in hazelnut orchards in the Fraser Valley, B.C.

Symptoms

Leaves can develop necrotic spots (usually less than 3 mm in diameter) that are reddish-brown and surrounded by a yellowish-green zone. The symptoms can also appear as small, dark brown or black spots on the green nut, although this is quite rare.



Bacterial blight on hazelnut leaves

<https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/nuts/hazelnut-bacterial-blight>

Bacterial blight can cause lesions which encircle the trunk of young trees and cause them to die. These lesions can be difficult to detect, but close examination shows the bark to be slightly sunken and reddish-purple in coloration. If you remove the bark at the crown with a knife, the tissue beneath is brown. A sticky liquid containing bacterial cells may ooze out of the lesions during periods of high humidity. Dead leaves will generally cling to the girdled trunks for some time. Blighting or dieback of infected branches can occur on trees of any age. It generally it does not attack or kill branches that are more than 3 years old. Dieback results in reduced yields.

Biology

The bacterium survives from one season to another in cankers and infected buds. Survival is better in large branch and trunk lesions than in the smaller twig lesions (less than 8 mm in diameter). The bacterial cells are spread throughout the growing season by rain splash, infected nursery stock, or contaminated pruning tools,

and they enter through natural openings or wounds on the tree. Temperatures above 20 °C favour infection, although infection can occur at low temperatures if the period of wetness is long enough. Wet weather is an important factor in the spread of bacterial blight. The pathogen from cankers is carried by water droplets and runoff onto branches below the canker- lesions on branches. Moisture must be present on the plant tissues for infection to occur, but the infection time on leaves can be as short as one hour if leaves are wet during that period. Disease incidence also seems to increase following freezing weather. This may be because the trees are weakened, or because there may be more entry sites through freezing injury

Identification and Monitoring

Scout young orchards regularly. Identification of the pathogen is the first step in controlling this disease. All young trees (including planting stock) should be inspected for the disease symptoms. Sometimes bacterial blight can be confused with other diseases such as sunscald and winter damage, but laboratory testing can confirm the presence of the bacterial pathogen. It is easiest to test for the bacterium during the spring. Buds can be infected but may not show symptoms for 5 to 6 months, meaning healthy looking trees can be already infected.

Management

Prune out infected branches below the canker lesions in the winter to reduce the source of inoculum. Burn or bury infected material and sanitize pruning tools after working on each tree.

Chemical control: It is important to protect young orchards. Chemical sprays are recommended in early summer to late August before the first heavy rains. If rains are heavy, apply copper-based bactericides (Table 7) during the fall when 75% of leaves have dropped and in the early spring when the buds are opening.

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/nuts/hazelnut-bacterial-blight>

EMERGING DISEASES

Besides EFB and Bacterial blight, new hazelnut varieties, particularly young orchards are susceptible to new diseases, not previously known to occur in British Columbia.

Young orchards planted with EFB-resistant hazelnut varieties can be affected by canker diseases caused by *Phomopsis*, *Cytospora* and *Diplodia* species and root rot caused by *Phytophthora*, *Pythium*, *Cylindrocarpon* species. Some commonly observed symptoms and the pathogens associated with them are included in Table 6.

Table 6: Diseases observed on young hazelnut orchards.

Diseases	Description of Symptoms	Management
Canker (<i>Phomopsis</i> , <i>Cytospora</i> and <i>Diplodia</i> species)	<ul style="list-style-type: none"> Dieback of affected branches, due to enlarging canker lesions on stems and tree trunk. Cankers appear as elongated brown to dark brown lesions with light yellow margin (<i>Phomopsis</i> sp.) or elliptical reddish-brown lesions (<i>Cytospora</i> sp.). As cankers mature the pathogens produces small, dark coloured spore producing structures called pycnidia (fruiting bodies) on them. Tissues beneath the cankers deteriorate, resulting in sunken lesions with cracked 	<ul style="list-style-type: none"> Conduct regular scouting for overall plant health and disease symptoms (canker lesions, 'flagging', dieback, etc.) during the season. Confirm the disease by using reliable diagnostic services. Prune out infected branches, at least 8-12 inches (20-30 cm) well below the canker tissues and dispose them safely. Fungicides (Bravo or Echo, Copper oxychloride or hydroxide, Cueva,

	<ul style="list-style-type: none"> • margins, and a 'wedge' shaped browning of tissues advancing towards the pith region • Defoliation leading to 'flagging' symptoms of infected branches and gradual dieback of infected branches. 	<p>Miravis, Due, Quash, Quadris or Azoshy and Flint) applied preventatively for EFB may help to reduce the infection by <i>Phomopsis</i>, <i>Cytospora</i> and <i>Diplodia</i>.</p>
<p>Root rot (<i>Phytophthora</i>, <i>Pythium</i>, <i>Cylindrocarpon</i> species)</p>	<ul style="list-style-type: none"> • Localized symptoms • Poorly developed foliage with smaller leaves • Yellowing of leaves (resembles to nutrient deficiency) • Defoliation • Weakening of plants 	<ul style="list-style-type: none"> • Select well-drained soils with good aeration and avoid excess irrigation. • Confirm the causal organism via a plant diagnostic service. • Currently, Orondis Gold, Phostrol and Rampart are available for managing <i>Phytophthora</i> and <i>Pythium</i> species, but there are no chemical products for managing <i>Cylindrocarpon</i> or <i>Fusarium</i>.

Table 7. Fungicides registered for use for use in hazelnuts. (This is a summary sheet only. Always check the Label)

Chemical name	Commercial Name (PCPA)	Chemical group (FARC Code [†])	Rate of Application	Pre-Harvest Interval (PHI)	Minimum Re-entry (REI)	Target Disease	Application guidelines
<i>Fungicides</i>							
Difenoconazole + Pydiflumetofen	Miravis Duo (33206) A20259 (33020)	3 + 7	1L/ha	14 days	When product dry	Eastern filbert blight (EFB)	Apply on a 14-day interval, starting prior to disease establishment. Apply as an air blast spray in sufficient water for thorough coverage.
mefentrifluconazole	Cevya (33405)	3	0.25-0.375L/ha	14 days	12 hours	Brown rot and blossom blight (<i>Monilinia fructicola</i> , <i>M. laxa</i>) Alternaria leaf spot (<i>Alternaria alternate</i>)	Apply preventatively. Repeat application at 7 to 14-day interval if disease persists. Do not apply more than 1.125L/ha per year
metconazole	Quash (30402) Metconazole 50 (30401)	3	245 g/ha	25	12 hours	EFB	Apply preventatively from bud swell to bud break, at 14-day interval. Do not exceed 4 applications per season.
metconazole	Quash SC (33081)	3	255 mL/ha	25	12 hours	EFB	
Oxathiapiprolin + metalaxyl	Orondis Gold (33508)	49 + 4	4L/ha	30 days	12 hours	Root rot (<i>Phytophthora</i> / <i>Pythium</i> spp.)	Apply preventatively at 2-month interval. Do not exceed 2 applications per year. Apply as a drench or soil spray under the canopy around the base of the tree to the zone of maximum root density, or through irrigation water (micro-sprinkler, drip, flood).

penthiopyrad	Fontelis (30331)	7	1-1.5L/ha	14 days	12 hours	Botrytis grey mould	Apply preventatively at 7 to 14-day interval. Max. 4.5L/ha per season.
azoxystrobin	-Quadris Flowable (26153) -Azoshy 250SC (32263)	11	900ml/ha in 1000L water	45 days	12 hours	EFB	Apply preventatively from bud break at 7 to 10-day interval. Do not exceed 3 applications per season.
trifloxystrobin	Flint (30619) (27519) CGA27920 2 (30427)	11	140-280g/ha	60 days	12 hours	EFB	Apply preventatively from bud break at 14-day interval. Do not exceed 4 applications per season.
Copper hydroxide ⁴	Parasol Flowable (25901)	M1	4.4 to 11.4 L/ha	2 days	48 hours	EFB, Bacterial blight*	Apply as a dormant spray (only) when ¼ leaves have fallen and again in early spring before bud set.
copper oxychloride ⁴	Guardsman Copper Oxychloride 50 (13245) Copper Spray (19146)	M1	3-9 kg/ha in 1000L of water	2 days	48 hours	EFB, Bacterial blight*	Apply preventatively at 10 to 14-day interval. Do not exceed 3 applications per season.
copper octanoate ⁴	Cueva (31825)	M1	470-940L/ha (0.5-2% solution)	1 day	4 hours	EFB, Bacterial blight*	Apply preventatively at 5 to 10-day interval. Do not exceed 3 applications per season
chlorothalonil ^A	Bravo ZN (28900) Bravo 500 (15723) Echo 720 (29355)	M5	6.72L/ha	120 days	18 days ¹ / 10 days ² / 2 days ³ / 	Eastern filbert blight (EFB)	Apply preventatively from bud break to shoot elongation at 20-day interval. Do not exceed 3 applications per season.
mono- and dibasic sodium, potassium, and ammonium phosphite	Phostrol (30449)	P07	2.9-5.8L/ha	0 days	12 hours	Root rot (<i>Phytophthora</i> / <i>Pythium</i> spp.)	Apply preventively via drip, drench or foliar in the spring or at first sign of symptoms at 14-day interval. Do not exceed 4 applications per crop cycle.
Mono and dipotassium salts of phosphoric acid	Rampart (30654)	33	3.0-6.0 L/ha	0 days	12 hours	Suppression of phytophthora root rot (<i>Phytophthora</i> spp.)	For preventative suppression of phytophthora root rot, begin foliar, drench or drip irrigation applications when conditions are favourable for disease (i.e., wet conditions or at early symptoms of disease).
Chemical name	Commercial Name (PCPA)	Chemical group (FARC Code[‡])	Rate of Application	Pre-Harvest Interval	Minimum Re-entry	Target Disease	Application guidelines

PCPA: Under the Pest Control Products Act (PCPA), pesticides imported into, sold or used in Canada are required to have a PCPA Registration Number. This number is listed on the product label.

‡ **FRAC Code** (based on risk of resistance development): M – low risk; 3 – medium risk; 4 – high risk; 7 – medium to high risk; 11 – high risk

As a result of the completed re-evaluation of chlorothalonil by the Pest Management Regulatory Agency (PMRA), effective **MAY 11, 2020 ALL MIXING AND LOADING OF BRAVO® ZN MUST BE DONE WITH CLOSED TRANSFER SYSTEMS.**

¹ Scouting ² Transplanting ³ Orchard maintenance

⁴Note that Copper is generally accepted for organic production. Check with the certifying agency.

*Bacterial blight- apply one of the copper products before fall rains, repeat when 75% of leaves have fallen, and then in spring before bud set. Use the low rate for small trees and the high rate for large trees. Apply in 1000 L water/ha by ground spray only.

- **Pesticides in Agriculture**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/pesticides-agriculture>

- **Integrated Pest Management**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/integrated-pest-management>

VERTEBRATE MANAGEMENT

MISCELLANEOUS PESTS

BIRDS

Birds can cause a substantial impact on yield by eating or pecking the nuts before harvest. Stellar jays and crows feed on ripening nuts. Flocks will congregate in hazelnut orchards and can have a substantial impact on yield. Wild turkeys will also feed on nuts in the fall and buds during the winter months.

Possible methods of controlling birds in orchards include physical exclusion, visual repellants and audible bird scare devices. Understanding the birds feeding behaviour can help when planning a control strategy.

CAUTION: The use of audible bird scare devices (ABSD) is regulated by the "Farm Practices protection (Right to Farm) Act". Several local governments have noise bylaws dealing with ABSD including, Delta, Pitt Meadows, Langley, Surrey and Abbotsford. Check with your municipal government area

Information on other types of bird control available can be found by visiting the following website: "Integrated Bird Management" https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/strengthening-farming/farm-practices/870218-60_wildlife_damage_interior_bc.pdf

As a general rule, multiple methods will be required to manage problem bird populations in orchards, and these should be initiated early. Vary the timing, placement and type of device throughout the season to avoid acclimation of birds to the repellant.

DEER

Deer occasionally causes serious damage on hazelnuts. They feed on the foliage, buds or nuts of many, and this can impact growth and yield. Bucks will also rub antlers against tree trunks, damaging bark.

Management

- Contact repellents- are applied directly to plants and repel deer by imparting an unpleasant taste. Some nut growers have found hanging bar soaps from trees around orchards to be helpful in deterring deer.
- Several types of fences are available for use around orchards, including permanent woven wire, mesh and electrical fences. These may be most economical for orchards in areas with large populations of deer where the likelihood of damage is high.
- Auditory and visual repellants- (propane cannons, strobe lights, sirens, etc.) can be effective in scaring deer off when they first appear, however deer generally become accustomed to them over the long term. Dogs contained in the orchard using invisible electric fencing are sometimes used to chase deer away. Odour or taste repellents are also available to manage deer in orchards.

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

RACCOONS

Raccoons can be a significant problem in hazelnut orchards and can remove maturing nuts from several acres of trees before harvest. They may also break the branches when climbing trees to feed on nuts.

Management

- Physical exclusion - There are no poisonous bait formulations registered against raccoons. Some growers of vegetables and other crops have found electric fences to be effective in deterring raccoons. These should be at least two-wire fences, with wires spaced 15 and 30 cm above the ground, although a three-wire fence, with wires spaced 10, 20 and 33cm above the ground, may provide better protection. Raccoons may also be hunted with an appropriate permit

British Columbia: <https://www2.gov.bc.ca/gov/content/environment/pesticides-pest-management/managing-pests/animals/raccoons?keyword=raccoons>

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

RODENTS

Squirrels, mice, voles and other rodents feed on nuts, roots and tree bark near the ground. Squirrels eat ripening nuts and carry mature nuts away. Mice and voles are often only a problem when populations are very high, as populations are often kept in check by their many natural predators.

Management

- Cultural techniques - Regularly mow grasses in and around orchards to 8-15 cm. This is typically done in hazelnut plantings to facilitate harvest and will help to remove cover needed by voles to breed and hide from predators. However, avoid mowing techniques (e.g., sickle bar mowers) that leave a thatch layer. Remove all mulch, sod, nuts and other debris at least 60 cm from the base of trunks or tree rows.
- Physical repellants - Mouse guards can be used to protect the bark of newly planted trees from vole damage. These should be buried 5 cm deep in the soil and require regular monitoring to ensure they are working and not interfering with root or bark development.
- Baiting/hunting- Where cultural practices are insufficient, toxic baits are available for use against mice in orchards. Baits are not registered for use against squirrels or raccoons. Squirrels may be managed with traps or through hunting, however, growers and landowners are responsible for ensuring all relevant legislation is followed

British Columbia: <https://www2.gov.bc.ca/gov/content/environment/pesticides-pest-management/managing-pests/animals/rodents>

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

For more information see **AF Production Guide Supporting Documents**.

Find downloadable supporting documents featuring: Metric Tables, Pesticide Regulations and Safety, Sprayer Calibration, and Sprayer Equipment

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides>

WEED MANAGEMENT

Weed management is critical to ensuring the good health of a hazelnut orchard. Weeds reduce nutrient availability, interfere with tree growth, and reduce hand-harvesting efficiency. To control weeds, a common practice is to apply herbicides down the tree row and flailing (mowing) between rows.

HERBICIDE CONTROL

Herbicides registered for use in hazelnuts fall into two classes: pre-emergent and post-emergent. Materials in these categories can be combined to get a knock-down and hold-down effect in one application. For best results, always follow the directions on the label. This makes you aware of the restrictions placed on the product used (such as use on new vs. established plantings, Personal Protection Equipment (PPE) required, Pre-Harvest Intervals (PHI), Re-Entry Interval (REI) plus other use information). Be sure to rotate the group of herbicides used on the orchard to reduce the development of herbicide resistance. When applying chemicals, ensure all safety protocols are met and worker safety is observed. This falls in accordance with federal and provincial regulations on pesticide use, application methodology, environmental impacts and worker safety regulations.

Take Note: In wet weather, weeds might become so abundant that they prevent or hinder normal harvest operations. If there is a possibility of abundant weed growth in the following year, apply a late-season, soil-residual herbicide to prevent weed germination. **Always ensure that any herbicide used is labeled for use on hazelnuts and has been checked for any potential effects on the hazelnut trees.**

WARNING: before using any herbicides (pesticides) carefully read the label and follow the instructions.

Table 8. Herbicides registered for use in hazelnuts. (This is a summary sheet only. Always check the Label)

Chemical name	PCP	Commercial Name	Chemical group	Pre-Harvest Interval (PHI)	Minimum Re-entry (REI)	Max. # of applications per season	Target Weed
<i>Herbicides</i>							
Indaziflam**	30451 30220 30221	Alion 200 SC Indaziflam 500 Indaziflam 200	29	14 days	12 hours	1	Annual grasses and broadleaf weeds
simazine	16370	Princep Nine-T	5	—	12 hours	1	Annual grasses and broadleaf weeds
halosulfron	31209	Sandea	2	1 day	12 hours	2	Broadleaf weeds
sulfentrazone	29012	Authority 480	14	3 days	12 hours	1	Annual grasses and broadleaf weeds
flumioxazin	29231 29235	Chateau WDG Flumioxazin 51	14	60 days	12 hours	2	Annual grasses and broadleaf weeds
glufosinate ammonium	28532 23180 32860 34332	Ignite SN Ignite 15SN Interline Opportunity 15 SL	10	14 days	12 hours	2	General weed control
Glyphosate*	25344 24359	Round Up Glyphos soluble	9	14 days	12 hours	---	Annual weeds
Carfentrazone-ethyl	28573 33987 34275	Aim EC Emphasis A Foremost	14	3 days weeds/30 days suckers	12 hours	2	Postemergence broadleaf weeds Sucker management

Acetic Acid	30248	Serene			Dry		Annual and perennial weeds
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PCPA: Under the Pest Control Products Act (PCPA), pesticides imported into, sold or used in Canada are required to have a PCPA Registration Number. This number is listed on the product label.

— Information not specified on product label

*See label for use-Many commercial products available

**Do not apply to trees that have been established for less than 3 full growing seasons after transplanting.

See also Orchard establishment section for more information.

For more information see **AF Production Guide Supporting Documents**.

Find downloadable supporting documents featuring: Metric Tables, Pesticide Regulations and Safety, Sprayer Calibration, and Sprayer Equipment

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides>

ORGANIC HAZELNUT PRODUCTION

Research show that it is possible to grow organic hazelnuts that are equal in quantity and quality to conventional produce and that fetch a higher price in the market (Tanrivermis, 2008), but organic hazelnut production is also associated with greater risks. The B.C. hazelnut industry is in recovery from a recent collapse due to Eastern Filbert Blight (EFB) and there are still many unknowns associated with new blight resistant varieties being planted, including how they will work in organic systems. The below information outlines different considerations for producers who are wishing to become certified organic hazelnut producers.

NOTE: As of September 1, 2018, the term “organic” is now a protected label within BC for agricultural products that have been produced or processed in BC, and for which certified organic programs exist.

Read more about organic certification for agricultural products in BC by visiting the following website: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/organic-food-and-beverages/organic-policy-update>

ORGANIC CERTIFICATION IN BC

Certification is a process of inspection and verification that is required for making an organic claim. The steps involved in the certification process are detailed below.

1. Choosing a certification agency
 2. Transitioning to organic production (36 months) for in ground crops.
 3. Developing a certifiable audit trail.
 4. Submitting an application to a certification agency
 5. Organic Inspection
 6. Review and certification
- } Steps 4-6 are an annual

STEP1. CHOOSING A CERTIFICATION AGENCY

The Certified Organic Associations of British Columbia is designated as the provincial organic program administrator. They oversee eleven certification bodies, a great diversity of agencies for producers to choose from. All of the certification bodies certify to the same standard: [CAN/CGSB 32.310 and CAN/CGSB 32.311](#). Considerations for choosing the right certification body for your needs include:

1. Market destination. If you plan to ship out of the province you must be certified by an agency that is ISO compliant. Check out the link below for a list of certifying bodies and details about whether they certify for National/International markets or are for products that will be solely marketed in B.C.
2. Cost
3. Reputation. Speaking with other organic growers may help you choose the best certification agency for your needs.

Visit the COABC website for information on the different certifying bodies, organic standards, the certification application process, and other frequently asked questions.

British Columbia: <https://organicbc.org/certification/>

STEP 2. TRANSITIONING TO ORGANIC PRODUCTION

1. Transition is the period of time between the start of organic management and the time a farm is brought into accordance with organic standards. '
2. Thirty-six months of transition is required from the last application of a prohibited substance.
3. A soil management plan must be implemented during that time.
4. The last 12 months of transition must be completed within a certification program. At minimum new applications must be submitted 15 months before a crop can be marketed as organic.
5. Enterprises must aim for a complete transition of its production. The enterprise can be converted to organic production one unit at a time. Parallel production (where the products of the organic and non-organic system are indistinguishable) is not allowed.

STEP 3 - DEVELOPING A CERTIFIABLE AUDIT TRAIL

1. Review all certification procedures to determine if you meet organic standards and regulatory requirements.
2. Implement record keeping (detailed production, sales and input records) for all pertinent aspects of your operation.
3. Create an accurate visual record (layouts, maps, flow diagrams).
4. List all production units, yields, varieties or if processing, current products.
5. Fill out application, also known as the Organic Farm Plan; attach map, diagram(s), sample record keeping, soil or irrigation water test if required by the Certifier, and where applicable labels. Submit completed affidavit. As well, submit a current water potability test especially if water is used during processing as an ingredient, processing aid or cleaning agent. Keep a copy of your complete application.

STEP 4 - SUBMITTING AN APPLICATION TO A CERTIFICATION AGENCY

1. The Certification Committee representative will complete a preliminary review of your application.
2. A 3rd party inspector will be assigned your file and an inspection scheduled.
3. The actual inspection may involve 1-5 hours depending on the complexity of the operation.

STEP 5 - ORGANIC INSPECTION

1. The inspector will verify all forms, maps and information supplied.
2. A visual inspection of the total operation, including your record keeping system, will take place.
3. An assessment of potential contamination points/risks will be made.
4. The inspector will submit a report to the Certification Committee.
5. The inspector does not determine status.

STEP 6 - REVIEW AND CERTIFICATION

The Certification Committee will assess the file and could:

1. Approve your request for membership.
2. Assign a status (transitional or certified organic) or,
3. Approve your request pending implementation of conditions or,

4. Deny your request based on their Standards.

The certification process is repeated annually. And even if you break the rules accidentally, you may be required to sell the affected product conventionally or even decertified.

SOIL MANAGEMENT AND FERTILIZATION

The basic principle of organic agriculture is soil building and maintenance. To satisfy this requirement most organic growers use compost. Compost not only supplies the soil with nutrients directly, it also provides organic matter which serve as a slow release source of nitrogen and important nutrients, conserves soil moisture, improves soil structure, and provides habitat for soil organisms to flourish. Other organic materials like blood and feather meals or fish fertilizers are supplements to and not a replacement for a proper soil building program.

Raw manures can be applied under very restricted circumstances; in the case of hazelnuts it must be applied at least 90 days before harvest. Manures from non-organic operations where livestock is fully caged and not able to turn 360° (e.g. veal or farrowing crates) or where animals are kept permanently in the dark are not allowed. The seasonal timing of manure shall ensure that manure does not run off into bodies of water or contribute to contamination of crops by pathogenic bacteria. Rates of application are determined by analysis of the compost for: nutrient and minerals, salts and pH; as well as the vigour, age, variety, and cropping history of the orchard.

Common materials used to make finished compost are livestock or chicken manures mixed with sawdust or woodchip. Acceptable compost feedstock include animal manure with restrictions as noted above; fish by-products and plant residue from any source; soils and minerals that conform to [CAN/CGSB 32.310](#) and 32.311. Use of these products requires documentation to confirm they are not contaminated with materials prohibited by the Standard, and if purchased that the material was composted effectively meeting the Standard. When using a new material or product it is always a good idea to check in with your certifier to ensure the products are permitted.

If you are making compost on the farm it must reach a temperature of 55°C for four consecutive days or meet CCME (Canadian Council of Ministers of the Environment) [acceptable levels](#) for human pathogens; otherwise operators must adhere to the raw manure application requirements laid out in the standards. You can use compost from off-farm as long as it: 1) is CCME Category A grade compost, 2) doesn't lead to a heavy metal buildup and, 3) meets CCME's human pathogen levels. See the "Compost obtained from on-farm sources" listing in Section 4.2 of [CAN/CGSB 32.311](#) for details.

Prohibited feedstock include sewage sludge, substances not included in the standard or prohibited by 1.4.1 of CAN/CGSB 32.310; leather by-products; glossy paper; waxed cardboard; paper containing coloured ink; animal products and animal by-products that are not guaranteed free of specified risk materials (refer to the "Bone Meal" listing in CAN/CGSB 32.311 section 4.2).

Growers exporting to Europe will need to confirm with their Certifier if additional documentation is needed to verify manures from non-organic farms came from animals that were not fed Genetically Engineered Organisms.

Micronutrients such as boron, magnesium and zinc can be used if a soil and/or leaf tissue analysis shows a deficiency. Mined minerals and unprocessed mined mineral are allowed sources of nutrients. Calcium chloride, only derived from limestone, can be used to address nutrient deficiencies and/or physiological disorders.

PEST AND DISEASE MANAGEMENT

Good monitoring is the basis of pest and disease management in organic growing. As a rule, sanitation and clean orchard practices are recommended in hazelnut orchards. Plant blight resistant and insect and pathogen-free nursery stock.

Long-term field trials with blight resistant hazelnuts have not happened in B.C. It remains to be seen whether i) Eastern Filbert Blight will still need to be managed to some degree, or ii) other diseases not previously an issue will present in the new varieties. Products used to control blight are limited to cultural practices (removing infected branches) and copper. Copper must be re-applied after rain, requiring multiple applications during the storm season. Too many applications can result in toxic levels of copper build up in the soil, so caution is required.

Biological control focuses on increasing populations of natural enemies. For example, mating disruption is being used to control Filbertworm:

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9198.pdf>

Pest Management in organic hazelnut Production. Available from:

British Columbia:

https://www.researchgate.net/publication/313991140_Pest_Management_in_organic_hazelnut_Production [accessed June 15, 2022].

Check out the disease and pest section of the guide (for conventional and organic). The major issues are the same for conventional and organic, and although there are less products available for organic there are still some products available. Organic growers must verify product acceptability with their Certification Body (CB) before use. Some certifying bodies have published approved lists. There is an industry driven initiative attempting to collate a national list of approved pest/disease/plant control and plant nutrient products. Interested growers should contact the [Organic BC](https://organicbc.org/) in Vernon.

British Columbia: <https://organicbc.org/>

WEED MANAGEMENT

There are no herbicides allowed in organic production registered in Canada. Mature orchards tend to have few weed problems due to shading, but weeds can be an issue in younger orchards.

Irrigation management, cultivation around the trees, mulching, and flaming are cultural controls used by both organic and conventional growers. There are times of the year when growth around the trees does not harm and can even be helpful. It is both possible and desirable to develop a tolerance for weed growth, or to even encourage certain beneficial species to grow around the tree.

PLANTING STOCK

You must plant organic growing stock if it is available. If it is not available, you can plant non-organic planting stock, but you must provide proof of attempting to attain organic planting to your certifier. Evidence is often in

the form of email correspondence or records of phone calls. Check in with your certifier about what type of evidence they require.

FENCING

Organic growers typically use metal or cedar posts, and other types of untreated wood and concrete are also allowed. If you already have CCA treated posts you will not have to remove them but once you enter a certification program, further purchases and installation are prohibited.

MARKETING, PROCESSING, & HANDLING

Typically, hazelnuts are washed, dried, sized, shelled, sorted, packed and pasteurized by processors. In order to process organic hazelnuts, processors will either require their own organic certification or sign an attestation of compliance. Attestations of compliance are generated for non-certifiable custom services including transport, storage, seed cleaning, etc. Signing an attestation means that they are familiar with all of the standards in terms of protecting the organic nature of the product (cleaning products, preventing any commingling of organic and conventional products, etc.) and promise that they have followed necessary steps to protect organic nature of the products.

Organic products are sold into different markets by different methods. Typically, organic growers are more involved in the marketing of their hazelnuts and will sell directly to consumers through farmers markets, box programs, or farm gate. While this does take more time, you are also much more in touch with market conditions.

SYSTEMS THINKING

Organic production is about taking a holistic approach to your farm system and being aware of the repercussions of every action. For example, mulching around tree trunks may seem like a great idea to manage annual weeds but what happens if this causes a rodent problem? Becoming an organic producer means responding and working with your system to create a balanced healthy population of predators and parasites, healthy soil, and plant communities. It is not a quick fix but is very rewarding in the long run.

OTHER RESOURCES

Oregon Organic Hazelnut Growers Association. This cooperative formed in 2017 and offers Organic Hazelnut Field Days, shared approaches to marketing and processing, and conducts and disseminates research.

Oregon: <http://oregonorganichazelnuts.org/>

REFERENCES

Tanrivermis, Harun. (2008) Comparative Economic Assessment of Conventional and Organic Hazelnut Farming in Turkey: Results of Questionnaires from Three Years. *Biological Agriculture and Horticulture*. Volume 26, Issue 3. Pages 235-267. <https://www.tandfonline.com/doi/abs/10.1080/01448765.2008.9755086>

APPENDIX-LINKS

General Information links about hazelnuts:

- **BC Hazelnut Growers Association**

British Columbia: <https://www.bchga.ca/>

- **BC Ministry of Agriculture**

British Columbia: <https://www2.gov.bc.ca/gov/content/governments/organizational-structure/ministries-organizations/ministries/agriculture>

- **Oregon State University Extension Service – Hazelnuts**

Oregon: <https://extension.oregonstate.edu/crop-production/nuts>

- **Ontario Ministry of Agriculture and Rurals Affairs (OMAFRA)**

Ontario: http://www.omafra.gov.on.ca/CropOp/en/spec_fruit/nuts/haze.html

- **BCAGRI Production Guide Supporting Documents**

Downloadable supporting documents featuring: Metric Tables, Pesticide Regulations and Safety, Sprayer Calibration, and Sprayer Equipment

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides>

INTRODUCTION

HAZELNUT BIOLOGY

- **Growing hazelnuts in the Pacific Northwest: Pollination and Nut Development**

Oregon: <https://catalog.extension.oregonstate.edu/em9074/html>

PLANNING CONSIDERATIONS

- **Soil type**

Oregon: <https://catalog.extension.oregonstate.edu/em9076>

- **Water Quality & Quantity: Licenses and Approvals**

British Columbia: <https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-licensing-rights/water-licences-approvals>

- **Light requirements**

Oregon: <https://catalog.extension.oregonstate.edu/em9077>
<https://catalog.extension.oregonstate.edu/em9076>

- **Proximity to Forest areas**

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

- **Intercropping**

Oregon: <https://catalog.extension.oregonstate.edu/topic/agriculture/hazelnut-production>

British Columbia:

Agroforestry Production Development Tool from UBC (APD Tool)

http://agroforestry.ubcfarm.ubc.ca/files/2013/03/APD-TOOL_Alley-Cropping_UBC-Farm1.xlsm

<https://www.youtube.com/watch?v=-adyiO4kKGg&feature=youtu.be>

- **Harvesting considerations**

Oregon: <https://catalog.extension.oregonstate.edu/em9079>

MANAGEMENT CONSIDERATIONS/NEW GROWERS

PRODUCTION ACTIVITIES, COSTS AND MANAGEMENT

- **Business management**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/business-market-development/agrifood-business-management>

BCHGA: <https://bchga.ca/>

- **AF Programs Services**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/business-market-development/agrifood-business-management/starting-a-new-farm>

COSTS OF PRODUCTION

- **A cost of production for a 10 acres hazelnut orchard in the Fraser Valley**

British Columbia: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/farm-management/farm-business-management/enterprise-budgets/hazelnut-2017_sh_august_2018.pdf

VARIETIES

- **Varieties and Pollinizers**

Oregon: <https://catalog.extension.oregonstate.edu/em9073>

<https://catalog.extension.oregonstate.edu/em9074/html>

<https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9073.pdf>

- **CFIA Directive: *D-00-03: Import requirements from the United States and domestic movement requirements for material to prevent the introduction of Eastern filbert blight into British Columbia***

British Columbia: <http://epe.lac-bac.gc.ca/100/206/301/cfia-acia/2011-09-21/www.inspection.gc.ca/english/plaveg/protect/dir/d-00-03e.shtml>

HAZELNUT TREE NURSERY

- **Nurseries**

Mosterman Plants Inc.

Contact person: Sylvia Mosterman

Website: <http://mostplantsinc.com/>

Mail address: 43583 Adams Rd. Chilliwack, BC V2R 4L1

Email: mostplantsinc@shaw.ca

Phone: 604 823 4713

Mountain View Acres

Contact person: Neil TeBrinke

Email: neiltb@hotmail.com

Phone: 604 796 3437

Nature Tech Nursery LTD.

Contact person: Thom O'Dell

Website: <https://www.naturetechnursery.com/>

Email: info@naturetechnursery.com

Pacific Coast Agriculture

Chilliwack, BC

Email: info@pcagriculture.ca

Phone: 604 798 2798

- **Processing Facility**

Fraser Valley Hazelnuts LTD.

Contact person: Kevin Hooge or Don Hooge

Email: kevin@fraservalleyhazelnuts.com

Phone: 604 997 7811 (Kevin)/ 604 793 3064 (Don)

ORCHARD DESIGN

- **Soil Management**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/soil-nutrients/management>

- **Drainage**

Ontario: <http://www.omafra.gov.on.ca/english/engineer/facts/10-091.htm>

- **Plant spacing**

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9077.pdf>

ORCHARD ESTABLISHMENT

MANAGING ESTABLISHED NUT BEARING TREES

- **Sampling procedures**

British Columbia: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/600-series/631500-1_soil_sampling_factsheet_no2_sep2010.pdf

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9014.pdf>

- **Nutrient testing laboratories**

British Columbia: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/600-series/631500-8_nutrient_testing_labs_factsheetno1_may2015.pdf

- **Fertilization**

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9080.pdf>

British Columbia: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/soil-nutrients/600-series/631500-9_soil_test_methods_factsheet_no3_sep2010.pdf

CANOPY MANAGEMENT

- **Types of pruning cuttings**

Oregon: <https://extension.oregonstate.edu/crop-production/nuts/basic-guide-pruning-hazelnut-trees>

ORCHARD FLOOR MANAGEMENT

- **Orchard Floor Management**

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9079.pdf>

HARVEST & POST-HARVEST OPERATIONS

- **Harvesting**

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

- **Post-harvest activities**

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

INSECT MANAGEMENT

- **Foliage Feeding Caterpillars**

British Columbia:

Bruce Spanworm: <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-bruce-spanworm.pdf>

Leafroller: <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-tree-fruit-leafrollers.pdf>

Ontario: https://www.researchgate.net/publication/289539650_Hazelnuts_in_Ontario-Pests

- **Aphids**

Ontario: https://www.researchgate.net/publication/289539650_Hazelnuts_in_Ontario-Pests

- **Scales**

Oregon: <https://pnwhandbooks.org/node/7373/print>

- **Filberworm**

Ontario: https://www.researchgate.net/publication/289539650_Hazelnuts_in_Ontario-Pests

Oregon: <https://pnwhandbooks.org/insect/nut/hazelnut/hazelnut-filbertworm>

- **Brown Marmorated Stink Bug**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/tree-fruits/brown-marmorated-stink-bug>

Ontario: http://www.omafra.gov.on.ca/english/crops/facts/info_bmstinkbug.htm#1st

US: <http://www.stopbmsb.org/>

Oregon: <https://catalog.extension.oregonstate.edu/em9102>

- **True bug**

US-Canada: <https://bugguide.net/node/view/666353/bgimage>

UK: https://www.britishbugs.org.uk/heteroptera/Miridae/phylus_coryli.html

- **General Hazelnut Production and Pest Management References:**

Oregon State University:

<https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em8979.pdf>

Ontario Ministry of Agriculture, Food and Rural Affairs:

https://www.publications.gov.on.ca/store/20170501121/Free_Download_Files/300751.pdf

- **Pesticides in Agriculture**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/pesticides-agriculture>

Oregon crop protection: <http://www.omafra.gov.on.ca/english/crops/pub360/pub360E.pdf>

- **Integrated pest management**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/integrated-pest-management>

DISEASE MANAGEMENT

- **Eastern Filbert Blight**

British Columbia: <https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/animal-and-crops/plant-health/phu-easternfilbertblightss.pdf>

Oregon: <https://pnwhandbooks.org/plantdisease/host-disease/hazelnut-corylus-avellana-eastern-filbert-blight>

- **Bacterial Blight**

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/insects-and-plant-diseases/nuts/hazelnut-bacterial-blight>

- **Pesticides in Agriculture**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/pesticides-agriculture>

- **Integrated pest management**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/integrated-pest-management>

VERTEBRATE MANAGEMENT

- **Integrated Bird Management**

British Columbia: https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/agriculture-and-seafood/agricultural-land-and-environment/strengthening-farming/farm-practices/870218-60_wildlife_damage_interior_bc.pdf

- **General Hazelnut Production and Vertebrate Management References**

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

- **Raccoons**

British Columbia: <https://www2.gov.bc.ca/gov/content/environment/pesticides-pest-management/managing-pests/animals/raccoons?keyword=raccoons>

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

- **Rodents**

British Columbia: <https://www2.gov.bc.ca/gov/content/environment/pesticides-pest-management/managing-pests/animals/rodents>

Ontario: http://www.omafra.gov.on.ca/english/crops/pub863/pub_863.pdf

WEED MANAGEMENT

- **Supporting documents**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriservice-bc/production-guides>

- **Pesticides in Agriculture**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/pesticides-agriculture>

ORGANIC HAZELNUT PRODUCTION

- **New BC organic certification regulation**

British Columbia: <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/organic-food-and-beverages/organic-policy-update>

- **Certification agency-Canadian Organic Standards**

British Columbia: <http://www.inspection.gc.ca/food/organic-products/standards/eng/1300368619837/1300368673172>

- **Organic Certification in BC**

British Columbia: <https://organicbc.org/certification/>

PEST AND DISEASE MANAGEMENT

- **Sustainable Hazelnut Production**

Oregon: <https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/em9198.pdf>

- **Pest Management in organic hazelnut Production**

British Columbia:

https://www.researchgate.net/publication/313991140_Pest_Management_in_organic_hazelnut_Production

OTHER RESOURCES-ORGANICS

- **Oregon Organic Hazelnut Growers Association.**

Oregon: <http://oregonorganichazelnuts.org/>