This chapter is part of
"A Manual of Integrated Pest Management for Urban Landscapes for British Columbia"
prepared in 1993 by Mario Lanthier and Linda Edwards
Integrated Crop Management Inc., Okanagan Centre, British Columbia
and submitted to the B.C. Ministry of Environment, Lands and Parks, Victoria B.C.

CHAPTER 4
SHRUBS, FLOWER BEDS AND DISPLAY GARDENS:
THE APPLICATION OF INTEGRATED PEST MANAGEMENT

TABLE OF CONTENTS

CHAPTER 4
SHRUBS, FLOWER BEDS AND DISPLAY GARDENS: THE APPLICATION OF IPM

INTRODUCTION

How much pesticides will be needed to control the mildew, the rust and the aphids of over 400 varieties of roses totaling 4,000 plants in a nine-acre tourist garden: ? None! Gardeners of this site in Eugene, Oregon used to apply more pesticide than all other applicators combined in their Parks Division. Since 1987, however, there has been no need for insecticide or fungicide applications because the gardeners have combined a variety of techniques to prevent and control insects and diseases.

The George E. Owen Municipal Rose Garden provides visitors with the beauty of formal plantings. The aesthetic standards are very high and the nature of the Garden requires planting some rose varieties known to be susceptible to diseases.

So how could they reduce pesticide use to almost nothing? Consistent with the Parks Division policy, the I.P.M. program was introduced on a small scale around 1980 and later expanded to other areas of the Garden. Predatory insects, soap applications and a better irrigation system were introduced to keep the aphids off the foliage. Disease control was achieved by keeping the plants healthy and improving the transplanting techniques. The disease-prone varieties were grouped together to limit the scope of fungicide applications.

The field staff were trained and encouraged to use creativity in applying IPM principles. In the first years, the number of “growing season” treatments was reduced by a program of "dormant season" applications of lime-sulfur and dormant oil. But the gardeners noticed some damage to the buds and shoots resulting from accumulations of dormant spray materials. In 1986, they removed the pre-emptive fungicide applications, and have maintained this practice.

The gardeners successfully eliminated the regular use of synthetic insecticides and fungicides while maintaining an attractive display. Their efforts were rewarded with the "Outstanding Rose Garden" Certificate in 1987 from the All-America Rose Selections.

Successful IPM programs often rely of the expertise of field personnel, and for urban landscapes this maxim is more evident in flower beds and display gardens than on any other site. Many municipalities across British Columbia and the rest of Canada feel proud of the reduced pesticide use in their flower beds, and in each case the expertise of the gardeners is a major factor for success. The gardeners are out in the beds on a daily basis: they know what works and what doesn't, which flower variety is susceptible to aphids, and when pests are present in damaging numbers.

Useful information about insects and diseases can be found in books and trade magazines, but the most valuable insights often come from direct observation and experience of the field staff and site managers.

A) SELECTION OF PLANTS

Selecting plants that adapt well to their intended site and fulfill their intended role in the landscape is extremely important to the success of a planting and the ease with which it can be maintained. This element has been discussed extensively in the Chapter 3: "Trees of Parks and Boulevards: The Application of IPM". Other considerations related to climate and pest resistance will be addressed here.

i) Selecting for the lowest expected temperature

In selecting and planting woody plants for a given area, it is important to know that they can withstand the coldest temperature expected. Local horticulturists or weather bureau records will be able to supply information on expectable temperatures. A "Map of Plant Hardiness Zones in Canada" is published by the Canada Department of Agriculture. This department also provides information on hardiness zones for most common shrubs cultivated in Canada. The “hardiness zone” is determined by the approximate range of average annual minimum temperature.

Although a region may have relatively consistent temperature regimes over several years, micro climates within the region vary considerably. Also, there will be the occasional low temperature out of the "average range", causing injury or death to many plants. Hardiness maps must be used with discretion.

Temperatures several degrees above the winter minimum can be devastating if they occur in late fall before plants have reached maximum hardiness, as it will cause a plant to lose some of its ability to withstand low temperatures. Similarly, plants are more susceptible to injury if the temperature drops quickly rather than slowly for several days. The early cessation of growth favors the early development of hardiness, and can be achieved with low levels on nitrogen and water in late summer.

Just as the temperature can become too cold for certain plants, areas with mild winters may not provide enough chilling to allow some plants to resume proper growth the following spring. For example, peach varieties may require from 350 to 1200 hours at, or below, 7^{o}C; trees not getting this chilling period will be slow to leaf out and bloom will be prolonged, which weakens the tree.

In general, the coastal areas of British Columbia are considered Zones 7 to 9, the South Interior is Zones 4 to 6, and the North Interior or high elevations sites are Zones 1 to 3.

ii) Selecting pest resistant varieties

Research in specialized books or contacts with skilled horticulturists will help in the preparation of a list of plants that will remain healthy in a particular climatic condition. Also, natural settings can be recreated by planting a variety of species. In such communities, pests are present but rarely build to infestation levels. The diverse landscape is also naturally appealing.

If a monoculture planting is required, such as in a rose or annual display bed, select varieties that are resistant to pest or diseases. Rose varieties and rhododendrons cultivars known to be pest-resistant are presented in Chapter 9: "Appendices".

Box 4-1: Aphid-free marigolds in Victoria

The harbour area of Victoria, in front of the Parliament Building, is one of the most frequented tourist sites in British Columbia. Every day of the year, hundreds of visitors walk around to enjoy the setting and take souvenir pictures. The gardeners for the City of Victoria take great pride in maintaining good looking displays with minimal pesticide use.

Annuals are grown for the constant splash of colors. In one large bed welcoming boaters to the harbor, marigolds are used in the summer and English daisies in the winter. In 1992, aphids infested the marigolds and the plants dried up from the feeding injury. Much time was spent monitoring the spread of the aphids and the presence of predator insects.

The gardeners associated the problem with cultural practices: one variety of marigold was severely affected, and aphids spread rapidly where the plants were close to one another. So, in 1993, the horticultural crew worked at establishing an aphid-resistant flower bed. A different variety of marigold was selected and the plants were spread further apart. Regular monitoring allowed the gardeners to keep track of localized infestation with the aphids.

Source: Bussiere, Hector. Ornamental Horticulturist (CIty of Victoria, B.C.) Personal Interview. July 12, 1993.

iii) Selecting native plants

In British Columbia, many attractive native plants provide the initial source for landscape shrubs and flowers. The use of native plants reduces pest management costs. Over thousands of years, these plants developed resistance to native pests. Because they come from wild stock, they are genetically diverse in comparison to highly bred horticultural varieties, conferring more resistance to pests. Finally, using a diversity of plants creates a more diverse landscape, reducing the possibility of major pest outbreaks.

The use of native plants also reduces irrigation costs in landscape settings. These plants are adapted to the dry summer and cold winter conditions in the province. Where dry periods are common, native plants have developed adaptive mechanisms, such as deep root systems, leaves coated with protective waxes, and the secretion of substances retarding evaporation. Such plants are useful in areas where water to maintain landscape plants is restricted in the summer.

According to Richard Hebda, of the Royal British Columbia Museum in Victoria, there are two approaches to using native plants in the urban landscape. The first is to encourage and maintain attractive native species growing along fence rows, property lines and corners of lots. Obviously, they are adapted to survive on those sites. The second approach is to plant native species in formal garden situations. For example, kinnikinnick (*Arctostaphylos uva-ursi*) is an excellent plant for dry open sites. This creeping evergreen shrub grows almost anywhere in B.C. and is extremely pest resistant. The Native Plant Garden of the Royal British Columbia Museum grows numerous native plants in down-town Victoria with few pest problems.

For areas managed by public agencies, naturalization with native plants can provide a cost-cutting benefit. Marginal park areas adjacent to creeks, forest and similar places can be planted with low-maintenance or native plants, reducing the needs for maintenance work or pesticide applications.

At the University of British Columbia, staff of the Botanical Garden have been cloning, breeding and micro-propagating native plants for many years. The goal is to produce superior garden varieties, with dependable characteristics and possible commercial success outside of B.C.. Their efforts have led to 6 plant introductions available in commercial nurseries: *Arctostaphylos uva-ursi* "Vancouver Jade", *Pentsmon fruticosus* "Purple Haze", *Potentilla fruticosa* "Yellow Gem", *Ribes sanguineum* "White Icicle", *Paxistima myrsinites* "Emerald Cascade", and *Vaccinium ovatum* "Thunderbird".

Box 4-2: Thimbleberry, a native plant suitable for landscapes

British Columbia boasts several multi-purpose plant species. For example our Oregon grapes (*Berberis* or *Mahonia* species) make excellent ornamental plants, whose fruits produce tasty jelly.

Few of our species, however, can match the thimbleberry of the Rose Family (Rosaceae) for utility. It not only has tasty fruits, but produces edible shoots, soap from its stems, and is an attractive and adaptable subject for gardens throughout the province. It forms waist- to chin-high tickets of erect stems. Unlike the closely related raspberries and blackberries, there are no thorns on the stems, but the bark is flaky and especially hairy on new growth.

Thimbleberry grows everywhere in British Columbia except the far north. Typical settings include open sites, often at the edge of woods, roadsides and shorelines. A widely adapted plant, it inhabits both moist and dry sites.

Thimbleberries are excellent subjects for naturalizing in moist corners of suburban lots. They seem not to be choosy about soil conditions and will grow on raw unprepared surfaces. In fact, in some localities they appear on their own. This plant can be ordered from the local nursery or garden centre.

Source: Hebda, Richard, "Native Plant of the Month: Thimbleberry", *The Island Grower*, June 1993.

B) MAINTENANCE CARE OF SHRUBS AND FLOWERS

Proper care is essential to the health of shrubs and flowers. Many maintenance practices were described in Chapter 3: "Trees Of Parks And Boulevards: The Application Of IPM". Other maintenance practices are described below.

Healthy plants better resist attacks from insects and diseases and benefit from proper site preparation and soil amendments. Controlling weeds helps plants fully utilise available moisture and nutrients and is done with mulches, ground covers and other methods.

i) Landscape installation

The landscape industry is very stratified between landscape architects, landscape contractors and maintenance personnel. Field personnel should be involved in the early stage of the design process, to communicate about the unintended maintenance and weed control headaches emanating from the design work.

Another important phase is the installation of the landscape. In many cases, municipalities are forced to tender out the new installations, with the lowest bidder being awarded the contract. Down the road, the savings from this process may be eroded in plant replacement costs and labor for fixing of problems.

Other considerations include the purchase of good quality plants for improved performance, testing of new soil for weeds before they spread to other beds, and careful inspection of the nursery stock at delivery time to detect insects or weeds. Finally, the installation of landscape plants too close to the lawn will result in damage by lawn mowers.

ii) Soil amendments and fertilization

Amendments are substances added to the soil to influence the physical, chemical and biological properties of the soil. These amendments improve the physical condition of the site by improving aeration, adding organic material and increasing the moisture capacity.

Organic soil amendments, such as manure, compost or peat moss, help create a well-balanced, fertile soil. This environment produces strong healthy growth and plants are better able to sustain pests and diseases attacks. By opposition, conventional chemical fertilizers provide necessary chemical components, but do little to enhance the soil structure.

Amending an entire soil area for shrub and flower beds is not always justified. In some cases, it is as effective and less expensive to break up the compacted surface, as soil compaction adversely affects plant performance. Soils are different around the province and require different amendments to improve the structure, pH and availability of nutrients. The decision of which material to use is based on soil tests done by recognized laboratories.

Box 4-3: Amending the soil with leaf mould in Port Coquitlam

Bill Herbst is Head Gardener since 1990 for the city of Port Coquitlam, a suburb of Vancouver. In 1993, Port Coquitlam was the first municipality to be awarded the "Environmental Initiative" by the B.C. Parks and Recreation Association.

Bill Herbst follows the city's "no-pesticide" policy and has adopted an organic gardening approach to horticulture. "The key to organic gardening is to feed the soil, not the plant", says Bill. "Overuse of chemical fertilizers produces plants which are lush and more susceptible to pest and disease attack."

The soil amendments include leaf mould, manures, bone meal, dolomite lime and compost. Other available organic fertilizers are rock phosphate, greensand, bonemeal, blood meal, cottonseed meal, fish and kelp meal

"All these products are excellent. Perhaps, leaf mould is the most valuable and accessible. It is easy to make and readily available in all park systems. When preparing a bed, leaf mould is incorporated into the soil in generous amounts. After the bed is planted, it is applied as a mulch to prevent weed seeds from germinating. It is quickly broken down and incorporated into the soil, so re-application is necessary every two or three years".

Source: Herbst, Bill, "Going 'Organic", *Recreation B.C.*, Spring 1992.

iii) Preventing weed problems

Weeds compete with landscape plants for water, nutrients, lights and space. In some instances, they harbor unwanted insect and pathogen populations. Even grasses can present a problem: Kentucky bluegrass, red fescue, perennial ryegrass and others will produce chemicals that suppress the growth of young plants. Weeds are part of an orderly plant succession: left to itself, bare ground is covered first with annual weeds, then perennial weeds and perennial grasses.

Monitoring

Annual weeds grow from seed, flower and die in one year, whereas perennial weeds grow for several years and usually have extensive storage roots. Control measures for annual weeds are designed to destroy the weed plants before they offer too much competition or before they go to seed. Manual cultivation or tillage are appropriate methods.

Perennial weeds are more difficult to control, because their underground stem and root systems must also be removed. For example, with the perennial weed couch grass (*Agropyron repens*), the above-ground portion of the plant can be manually removed, but the weed will grow back from the roots.

Common perennial weeds in shrub and flower beds include couch grass, bindweed (*Convolvulus arvensis*), loosestrife (*Lythrum salicaria*), and Canada thistle (*Circium arvense*). They are controlled with repeated cultivation or spot herbicides. Such weeds are the focus of monitoring efforts, because a treatment within the first 4 to 6 weeks after emergence from seeds will prevent their establishment as perennials.

Manual cultivation

Cultivation, the preparation of shrub and flower beds, helps incorporate organic matter and remove young weed plants. It is also effective in removing small weed plants around landscape plants. Established weed infestations are rarely eliminated using cultivation or hand removal. However, with frequent monitoring to eliminate new growth, the food reserves are slowly depleted and the weed is eliminated by starvation.

Manual cultivation presents disadvantages. It injures the shallow roots of established shrubs and flowers. Under wet conditions, such as during winter months on the Coast, the soil structure is readily damaged by cultivation. During dry summer periods, cultivation exposes the soil and the roots around the landscape plant and severe wilting can follow.

Ground covers

The use of ground cover plants to out-compete the weeds is now a popular practice. For example, herbaceous perennials are colorful, grow quickly and provide strong competition against weeds. Ground covers fill the space between immature landscape shrubs and reduce light, water and space available to the weeds. A suitable ground cover plant is strong, self-reliant, grows thickly, and is attractive in the landscape setting with its foliage or flowers. They include low-growing shrubs, vines and herbaceous perennials. Bulbs and annual flowers are included to add some color.

The advantage of ground covers is the reduction in weed growth and applications of herbicides. Disadvantages include the cost of establishing the plants and weed control for the first 1 or 2 years until the plants cover the soil completely.

As with all other trees and shrubs, young ground cover plants cannot grow against established weeds or thrive in soil devoid of nutrients. All perennial weeds must be eliminated from the planting bed before introducing the ground covers. Trying to extract weeds from a dense knotted carpet of plants is a difficult and expensive task. Bill Herbst, Head Gardener for the city of Port Coquitlam, recommends against the use of low growing shrubs such as cotoneaster, ivy and some junipers: the dense branch net makes weeding difficult and the low maintenance aspect of ground covers is eliminated.

For landscape site construction, the first plants to introduce are the trees and shrubs. The herbaceous perennials are installed between shrubs, but not close to the trunks, to out-compete the weeds. Many small plants will cover the soil quicker than a few large plants. Bulbs go last to prevent accidental mutilation. Most ground covers, particularly vines, must be pruned to keep them in bounds and attractive.

Box 4-4: Good herbaceous ground covers

Alyssum (*Aurinia saxatilis*)

An early spring rock garden and wall plant. Compact clusters of flowers are supported by gray, evergreen foliage forming a mound 20 cm high. Long-lived and requiring little care. Sun exposure.

Kinnikinnick (*Artostaphylos uva-ursi*)

Native to the West Coast mountains where it scramble over rocks. Branches spread from a humped centre to form a mound 45 to 60 cm high. An unexcelled evergreen with bell-shaped flowers and red fruits. Sun exposure.

Periwinkle (*Vinca minor*)

Native to the Mediterranean region. The nonflowering stems carry ovate dark green leaves in opposite pairs, whereas the flowering stems are above the others and produce pairs of bright blue flowers. There are variegated varieties. Particularly useful beneath trees.

Rose-of-Shanon (*Hypericum* sp.)

This is a large genus containing herbaceous and shrubby varieties. This groundcover is native to eastern Europe. It forms a dense mat of any sunny bank or highway roadside and large plantings are showy. Leaves are lost during the winter, while bright golden flowers are produced during the summer.

Thyme (*Thymus* species)

Native to the Mediterranean region, it comes in a variety of sizes and scents. The tallest is *T. vulgaris*, the garden thyme, growing to about 30 cm, woody stemmed, with aromatic leaves used for flavouring in cooking. Prefers a sandy, well-drained soil.

Source: Bill Herbst, Port Coquitlam and

Mulligan, B.O., "Groundcovers and Small Shrubs", in: "Trees and Shrubs for Coastal British Columbia Gardens", Whitecap Books (Vancouver, B.C.), Second Edition, 1990.

Herbicides

Herbicides are chemical products designed to inhibit or kill undesired plants. Some herbicides are very toxic to human health, and all products must be used with care. Herbicide selection is determined by the weeds growing at the site and label instructions.

Herbicides are classified in a number of ways. One classification is based on the mode of action: contact or translocated. Contact herbicides kill only the plant part they contact (for example, paraquat). They are usually not selective, kill everything they strike, and can seriously injure young landscape plants. Contact herbicides are used for localized applications or spot treatments in established beds with annual weeds, where they provide quick cosmetic clearing. They provide little long-term effect in removing perennial weeds.

Translocated herbicides move from the treated leaves down through the root system, killing the whole plant (for example, glyphosate). These herbicides are excellent for the control of some perennial weeds, but have limited effect on the most persistent ones. The affected weeds and plants take several days to show damage. Translocated herbicides are used for pre-planting weed control or spot treatments in established beds with perennial weeds.

Another classification is pre-emergent herbicides which are applied to the soil before the emergence of weed seedlings and have no effect on weeds already growing. Some pre-emergent herbicides have residual activity and are use as a preplanting treatment (for example, Simazine). Others affect only grasses, present no problem to the landscape plants, and are applied to keep ground cover and shrub plantings weed free (for example, napropamide or dichlobenil).

Landscape plants are injured by exposure to herbicides, by direct contact, by the drift at application time, or by accumulation of the chemical in the root zone. Symptoms vary with the herbicide and the plant species, but in most cases the affected plants exhibit veinal or interveinal and marginal chlorosis in the leaves, followed by necrosis and leaf fall. Plants may be weakened and become susceptible to disease pathogens.

Box 4-5: Herbicide injury to shrubs

For landscape plants, the greatest risk of injury comes from the herbicides **paraquat (Gramoxone)** and **glyphosate (Roundup, Laredo)**. For both products, injury occurs because of contact with the foliage or absorption through thin or green bark. These compounds are inactivated upon contact with the soil, so shielded sprays or applications prior to transplanting are safe.

Simazine (Princep) and **dichlobenil (Casoron)** pose a certain risk to landscape plants, as few species can tolerate these compounds. The injury can occur if applications are made to sensitive species or if the application rate is excessive. Plants will usually outgrow the damage.

Simazine accumulates in the soil, and replanting a site is a problem where simazine was applied for a number of years. A small liner cannot tolerate the levels of simazine or dichlobenil that an established tree or shrub can tolerate. Nursery plants must be established in the ground at least one year before an application can be made.

The grass herbicide **fluazifop (Fusilade)** is generally quite safe to most ornamentals. However, there are cultivars sensitive to this chemical. The injury symptoms are tip burn and spotting of foliage and petals.

Certain **dinitroanilines (Treflan)** or **amides (Devrinol)** can be used on newly transplanted and established ornamentals and are safe to most woody landscape species. An injury may result from an excessive rate or from application to a sensitive species. Application to poorly-rooted liners can also cause injury, whereas an established plant of the same species would not be affected. Stunting of roots and shoots is the predominant symptom.

Source: Derr, J.F. and B.L. Appleton, "Herbicide Injury to Trees and Shrubs: A Pictorial Guide to Symptom Diagnosis", Blue Crab Press (Virginia Beach, VA), 1988.

iv) Mulches

The use of mulch in landscape beds has increased in recent years with the use of a wide variety of materials. In many cases, the mulch is used for weed control.

Plastic mulches give excellent control of annual weeds and are more effective than organic mulches against perennials. However, if the plastic mulch is torn, weed growth through the hole will be vigorous. They are often used in combination with bark mulch, gravel or other decorative covering.

Organic mulches are effective against annual weeds and against germination of perennial weeds, but have little effect on established perennials. Perennial weeds will emerge, even through deep layers of organic mulch. Thus, a complete cleaning of the landscape bed to remove all weed roots is necessary before the installation of organic mulches.

The benefits of mulches extend beyond their capacity to control weeds. Overall, they reduce the stress on landscape plants and allow them to perform better. The increased plant performance can be associated with a number of factors: soil moisture is preserved, soil fertility is increased with wood materials decomposing, soil compaction is reduced, root system is more extensive and soil temperature extremes are moderated.

On the negative side, buying and installing mulches is more expensive than herbicides, especially for plastic materials. Some mulches create a perfect winter habitat for mice. The management of fertility requires more attention with organic mulches: decomposing wood fibre ties up nitrogen from the soil, making it unavailable to the plants. With plastic mulches, granular fertilizer stays on the surface of the plastic instead of being released at the root level.

Overall, where weed control is the major consideration, herbicides have an important advantage in their convenience and relative ease of application. Where improved plant growth and vigor are important, mulches offer greater benefits than herbicide treatments. Where herbicide use is not possible, because of regulations or public health concerns, mulching is a viable weed control option.

Box 4-6: Mulch characteristics

ORGANIC MULCHES

Sawdust and wood shavings

Advantages: Available and comparatively inexpensive in many areas. Decomposition adds humus to the soil.

Disadvantages: Break down rapidly. Nitrogen must be added to the soil or the sawdust to avoid nitrogen depletion. Not all of the water reaches the soil.

Chunk bark and wood chips

Advantages: Coarse texture. Let water in effectively. Keep down weeds. Improve the water-holding capacity of the soil.

Disadvantages: Not always available, except regionally. Breaks down slowly. Takes nitrogen from the soil during the initial decay process.

Lawn clippings

Advantages: Readily available. During mowing, leave the clippings on the lawn or direct them over plastic mulch in flower beds.

Disadvantages: May contain weed seeds. Do not use clippings from a lawn treated with herbicide. Create offensive odor if not dried before piling.

Leaf mould

Advantages: Lets some water in and keeps it in. Readily available at little or no cost, but should be partially rotted before being applied.

Disadvantages: Leaves may pack too heavily when applied over tender herbaceous perennials. Harbor insects, diseases, weed seeds, rodents.

INORGANIC MULCHES

Plastic film

Advantages: Holds water in very effectively. Controls weeds unless holes are punched to allow water in. Easy to transport, thin, light.

Disadvantages: Must be covered with organic material. Doesn't work well on slopes because covering material slides off. Labor-intensive to install.

Woven fabrics

Advantages: Good weed control. Combined with organic mulch for pleasing appearance. Experiments show improved plant performance.

Disadvantages: Expensive. Labor-intensive to install. Excellent control of annual weeds may create favorable habitat for perennial weeds.

Crushed stone

Advantages: Lets all moisture into the soil, keeps moisture in root zone.

Disadvantages: May change the soil chemistry when it breaks down. Will not prevent growth of some weedy grasses unless combined with plastic barrier.

Source: Ellefson, C., T. Stephens, D. Welsh, "Xeriscape Gardening. Water Conservation for the American Landscape", Maxwell Macmillan Canada (Toronto, Ont), 1992.

C) INSECTS AND DISEASES OF SHRUBS AND FLOWERS

Some insect and disease problems found in British Columbia are presented in the following pages to illustrate how local practitioners have developed programs for a specific situation. This information should be seen as an illustration of how to approach the problems.

i) Rose diseases

Powdery mildew, *Spaerotheca pannosa*, starts on young leaves as raised blisterlike areas that cause leaves to curl. Infected leaves soon become covered with a grayish-white powdery fungus growth.

Symptoms of black spot, *Diplocarpon rosae,* include circular black spots on canes and leaves. Spots may coalesce to produce large, irregular lesions.

Rust, *Phragmidium* species, is recognized by small orange or yellow pustules appearing on the green portions of the plant.

Monitoring

Monitoring begins in the spring for the three diseases. For powdery mildew, check growing tips and young leaves for signs of powdery growth. Temperatures around 16^{o}C and high relative humidity enhance its development. For black spot, check the leaves near the ground and the young leaves at the top of the plant for signs of dark-colored spots. Abundant rain or humidity in the spring are favorable conditions, as spores must be wet continuously for 7 hours for infection to occur. For rust, check for pustules on the undersides of leaves on new foliage. Heavy dew, rain or fog near the cost are favorable conditions.

Control treatments

Planting resistant varieties helps in the prevention of rose diseases. Newer rose hybrids are bred for enhanced bloom characteristics and their susceptibility to diseases is not well known. With older varieties, experience over time shows which cultivars are disease resistant.

Agriculture Canada has rated a number of rose varieties at a Research Station in Manitoba, and the information is reproduced in the B.C. "Nursery Crop Production Guide". Roses are also ranked for susceptibility to diseases at the Oregon International Rose Test Garden, Portland, and the information is available from the "Plant Disease Control Handbook" of Oregon State University. Plants recommended for the Burnaby Centennial Rose Garden by members of the Vancouver Rose Society in 1991 are listed in Table 9-6.

The removal and destruction of infected leaves and canes is an effective method for limiting the spread of the three diseases. The spores over-winter inside leaf buds formed on canes or on fallen leaves. Thus, raking and disposing of the leaves on the ground in the fall, pruning of the infected canes in the winter and removing infected leaves during the spring and summer reduces the pressure from the diseases.

Box 4-7: Least-toxic recommendations for managing rose diseases

1- Plant varieties tolerant of or resistant to the diseases of in the area.

2- Plant roses in full sun, and space them a minimum of 3-4 feet apart to encourage air circulation.

3- In fall, rake up and discard all fallen leaves and other plant debris that could contain over-wintering spores.

Also in the fall, after cutting back and before winterizing, an application of fixed copper to the stems and surrounding soil will reduce the overwintering spore population.

4- In late winter, prune off and discard all diseased canes and any remaining foliage.

5- Before buds swell in spring, apply 2-3" of organic mulch under rose bushes to cover any over-wintering disease spores lodged on the ground.

6- When foliage emerges in the spring, monitor for signs of disease and prune off infected parts of the plant. Continue to lightly prune off infection throughout the growing season.

7- Water rinsing of the plant is effective to remove spores of powdery mildew and black spot. These washes are done during periods of active growth, in the morning hours of dry days. Spores thrive in humidity but are washed away by water.

8- If disease levels appear to be growing despite conscientious application of the tactics described above, spray with a recommended fungicide.

Source: Daar, Sheila, "Rose Diseases: New, Less Toxic Controls", *Common Sense Pest Control*, 1(2): 4-10, 1985.

ii) Root weevils on rhododendrons

Root weevil species most common in British Columbia include the black vine weevil (*Otiorhynchus sulcatus*), the strawberry root weevil (*Otiorhynchus ovatus*), the rough strawberry root weevil (*Otiorhynchus rugosostriatus*), the clay-coloured weevil (*Ituirgtbcgys subgykarus*), the obscure root weevil (*Sciopithes obscurus*) and the woods weevil (*Nemocestes incomptus*).

These species overwinter as partially mature larvae or as adults. The larvae feed on roots during the winter if the temperatures are mild, and do the greatest damage in March and April before pupating in the soil. From the moment they emerge in spring through fall, flightless gray or black adult weevils (beetles with snouts) eat notches from leaf edges of many plants - especially azaleas and rhododendrons, roses and viburnums. They lay eggs on the soil in late summer that hatch into larvae with pinkish or whitish bodies and tan heads.

Monitoring

Monitoring should begin in late May or early June. On sunny days, the weevils are found in the leaf litter and duff under the plant. On cloudy days, the weevils tend to remain on under the leaves. An effective method is to inspect the plant with a light after sundown. Another technique is to lightly beat the plant to dislodge the weevils, so they can be identified.

Control

The adult weevils feed mostly at night on rhododendron and other plants and can be controlled by pyrethrins and other insecticides. The rate of application and timing are critical for best control, as many of the available insecticides have short residual activity. To be most effective, foliar applications should begin at the first appearance of adults in early summer and before they start to lay eggs, and done late in the day to catch the night-feeding adult.

The control of larvae is more difficult. A biological control being investigated in B.C. is the use of insect parasitic nematodes in a soil drench. Nematodes are microscopic worms that thrive in moist soil, seek out hosts such as larval weevils to feed upon, and are non-toxic to plants and people when used properly. They are most effective when the soil is wet and above 15.6^{o}C (60^{o}F). In certain parts of B.C., low soil temperature in the fall may limit their use.

Finally, sanitation is also an essential element in effective root weevil management. Weevils migrate on foot and lay eggs in soil, thus infesting plants that may show no foliar injury. Border and other host plants are treated or removed, infested root-soil materials and potting media is destroyed or treated to eliminate the eggs, larvae and pupae.

Some rhododendron hybrids have been ranked for their resistance to adult root weevil injury by specialists at the Washington State University and are listed in Chapter 9.

Table 4-8: Entomopathogenic nematodes

The entomopathogenic nematodes *Steinernema carpocapsae* and *Heterorhabditis bacteriophora* and their symbiotic bacteria *Xenorhabdus* species are both naturally occurring soil organisms throughout North America. Their safety to the environment and non-target organisms has been well documented, and these nematodes will not attack or damage plants in any manner.

The nematode enters insects through natural body openings and then penetrates into the insect blood system. There, it releases the bacterium it carries within its intestine. Depending upon temperature, the bacterium will multiply rapidly and kill the insect host within 24 to 48 hours.

Entomopathogenic nematodes are primarily used for controlling insect pests in which some portion of a susceptible life stage occurs within the soil. Generally this is the larval stage, but occasionally adults are infected as well.

The most critical factor in improving nematode efficacy is adequate soil moisture: they depend on a film of water surrounding the soil particles for movement. If the soil is allowed to dry out, then nematodes cannot move and search for hosts and will die from desiccation. Pre-irrigation and post-irrigation are recommended for the treated soil.

Source: Fisher, G. et all, "Pacific Northwest 1992 Insect Control Handbook", Oregon State University (Corvallis, OR), 1992.

iii) Dogwood Anthracnose

Identification

The disease Dogwood Anthracnose is now widespread in south coastal B.C.. It appears as brown spots, blotches and wedge-shaped areas at leaf tips. Occasionally, instead of blotches, leaves have brown spots with dark brown to purple margins. Premature defoliation occurs and twigs and branches may develop cankers and die-back. The presence of dead terminal buds, and leaves remaining attached to dead branches in the spring, are characteristic symptoms. This disease is favored by periods of wet weather.

The responsible fungus is a *Discula* sp. (*Gloeosporium* sp.). It overwinters on dead twigs, leaves on the tree, and fallen leaves. The tiny brown fruiting bodies of the fungus can be easily seen on these dead twigs and leaves. The disease is most common on native dogwoods but has also been identified on ornamental species.

Control

A number of control methods are available. Some varieties have more resistance to the disease than *Cornus nuttallii*, the Western Dogwood: these resistant varieties include *Cornus florida* 'Eddie's White Wonder' (Easter Dogwood cultivar) and *Cornus kousa* (Japanese Dogwood).

On infected plants, the infected twigs are pruned and destroyed, and fallen leaves raked up and destroyed as well. This will reduce the spread of the disease by eliminating the fruiting bodies. Fungicides can be applied on a preventive basis starting at bud break and during rainy periods later in the season.

Dogwoods receiving good cultural care will be better able to withstand anthracnose during the years in which the disease is favored by environmental conditions. This includes a balanced fertilizer program and supplemental watering during drought periods, as these plants have a shallow root system.

Lower branch dieback

Dogwood anthracnose is a fairly new disease in North America. First reports came around 1978 of a rapid deterioration of *Cornus florida* in New York, followed by similar observations on *Cornus nuttalii* in the Pacific Northwest in 1979. Some researchers first called the disease "lower branch dieback", as the most characteristic symptom of dogwood anthracnose is the yearly twig and branch death beginning in the lower part of the canopy (Daughtrey, Hibben and Hudler, 1988).

Other diseases and insect injuries are occasionally observed on the declining dogwoods. These include root rot, leafspot, blight of flower bracts, dogwood borer and dogwood gall midge. It seems that infection by *Discula* sp. predisposes the dogwoods to injury by other pests.

For example, infected *C. florida* in woodland sites show far greater winter kill than other dogwoods. Another fungus disease, *Armillaria mellea*, is often seen attacking native dogwoods infected with anthracnose, thus hastening their death. Borer infestation, although not a significant pest in nature, has been observed on some declining dogwoods.

iv) Tulip fire

A bed of tulips in Vancouver in 1993 will not necessarily be there in 1994 because of a disease called tulip fire (*Botrytis tulipae*). Entire tulip fields, set-out for the spring display of colors, have been destroyed and the disease threatens thousands of tulips across the city.

Identification

Tulip fire fungus overwinters in the soil on affected bulbs and other affected plants parts. Under moist conditions, the rot develops on the leaves and flower stalks, causing a light gray discoloration bordered by brown margins. The stems may rot off completely, the whole plant becomes dwarfed and turns a pale yellowish-green, and the flower is destroyed. The diseased parts are covered with a gray mold. On the bulbs, infection is seen from the spots on scales beneath the outer husks or from a spongy texture.

Gardeners spread the disease to unaffected beds with their implements before the damage can be seen. In 1993, a wet spring made conditions worst, as the soil was moist for a long time, allowing the movement of fungi spores from one plant to another.

Monitoring

Botrytis diseases are probably the most common and most widely distributed diseases of ornamentals and food crops throughout the world. Under humid conditions, the fungus produces a noticeable gray-mold fruiting layer on the affected tissues that is characteristic of the *Botrytis* diseases, including gray mold of strawberry, blight or gray mold of ornamentals such as begonia, cyclamen, chrysanthemum, lily, rose, snapdragon and tulip, bulb rot of amaryllis, corm rot and leaf spot of gladiolus, along with the gray mold rot of many vegetables and fruits.

Bulbs are carefully inspected before they are planted. The outher husks are removed to disclose any diseased spots on scales beneath. These are numerous blackish or brown areas. All bulbs showing infection are discarded. When the disease appears in the bed, the affected plants are removed without leaving in the soil any infected bulb scale.

Control

Control of Botrytis diseases is aided by the removal of infected and infested debris from the field and storage rooms, and by providing conditions for proper aeration and quick drying of plants and plant products. Control of Botrytis in the field through chemical sprays has been only partially successful, especially in cool, damp weather.

For public areas around Vancouver, when only a few plants are affected, they are removed from the bed and destroyed. For larger infestations, the complete bed is controlled: all bulbs are removed and destroyed, the soil is replaced, and the bed replanted with bulbs of disease-resistant flowers such as daffodils. The disease remains in the soil for a long time, so susceptible flowers such as tulips, hyacinths and fritillarias are kept away from infected beds for up to 5 years. The soil fungicide quintozine is sometimes used on the bulbs at planting time.

v) Earwigs

Identification

The European earwig, *Forficula auricularia*, can be a serious pest of gardens and households and is common throughout B.C. In landscape situations, earwigs attack a great variety of flowering plants, causing severe injury to dahlias, pinks, carnations and zinnias. Typical injury of earwigs appears as numerous, small, irregular holes in the leaves. Seedlings are devoured completely, and the larger plants are subjected to varying degrees of defoliation. The terminal buds of dahlia are eaten, causing the plants to become misshapen. The flower buds are also injured and produce deformed blossoms.

Earwigs as predators

Earwigs can also be useful predators and have been the central focus of biological control of aphids and other insects in research projects. Experiments in Washington State in 1984 showed that, when five to six earwigs were released on young apple trees, the number of apple aphids, *Aphis pomi*, declined over 3 weeks compared with control trees.

An important attribute of earwigs is their inability to fly, making their dispersion slow. An experiment conducted in the Okanagan Valley showed that marked earwigs released from a central site dispersed throughout the block. However, more than month after their release, most of the earwigs were still found on the tree of release (see Table 4-9).

Trapping of earwigs

Another important attribute of earwigs is the relative ease to move them. Burlap bags, newspapers or other materials near areas where they occur will provide hiding places for the earwigs during daytime. Clever pest managers will trap earwigs out of undesired plants and move them to sites of high aphid populations, thereby putting the earwigs to proper use. If the experiments with pear trees have validity with other plants, the earwigs most likely will remain close to the new release site and may provide long-term control of the pest aphids.

The potential use of European Earwigs to control aphids in landscape situations is considerable but has not been researched. If used properly, on a small scale, and with great care for the plants, they may become an important tool of pest managers for the control of aphids and other slow-moving, soft pest insects.

Table 4-9: Dispersal of European earwigs in a commercial pear orchard

Distance from release point	Proportion of earwigs found
12 days after release	
0 meter from release	62.1%
5 meters from release	7.2%
10 meters from release	0.0%
33 days after release	
0 meter from release	26.9 %
5 meters from release	15.5 %
10 meters from release	2.8 %

Adapted from Powlowski, R. et al, "The Development and Implementation of a Predator Based Control Program for the Pear Psylla, *Cacopsylla pyricola*, and Other Pear Pests", Integrated Crop Management Inc. and B.C. Fruit Growers' Association (Okanagan Centre, B.C.), 1993.

vi) Cutworms and Armyworms

Identification

Several species of cutworms and armyworms attack landscape plants, including the Bertha armyworm (*Mamestra configurata*), the Black army cutworm (*Actebia fennica*) and the Variegated cutworm (*Peridroma saucia*). They may be present in small numbers causing minimal damage, or become severe pests and cause complete defoliation.

Cutworms are generally black to brown or gray and without distinct markings. They overwinter as half-grown larvae and attack plants in the seedling stages in spring and early summer. They will feed on and cut the plants below ground level or within the plant stems.

Armyworms are foliage feeders and attack crops in mid- to late-summer in most instances. They can cause extensive defoliation. Armyworms are generally more brightly colored with distinctive markings that make them easier to identify than cutworms.

Monitoring

Most of these insects feed at night and on overcast days, hiding in the ground, curled up, in the daytime. The first evidence of a problem is "shot-hole" feeding damage on vegetation early in the spring. They feed on herbs, shrubs, and young trees. Cutworm damage also results in seedlings cut off at ground level or slightly higher.

Control

If seedling plants are lost to cutworms one year, replacement plants should be protected in subsequent years. In small areas, plants are protected from cutworms by using barriers or by placing a collar around the plants at transplanting time. One simple barrier is a cutoff milk carton sleeve with 1 inch below soil level, 2 inches above, and at least an inch between the sleeve and the plant. Weeds removed in August will help reduce the incidence of cutworms in the following year.

Chemical controls are not very effective against mature cutworms but help control young worms. One least-toxic pesticide option is the use of *Bacillus thuringiensis*. Evening applications and a suitable spreader sticker contribute to the success of this product. Preliminary experimental results show some control from entomopathogenic nematodes.

vii) Deer

Identification

Deer can cause serious damage to home gardens in suburban and rural areas of the coast and interior regions of the province. Two species of deer are native to B.C. The mule deer, *Odocoileus hemionus*, is widely distributed throughout the province. The white-tailed deer, *Odocoileus virginianus*, is abundant in the southern interior including the Kootenays and the Okanagan Valley.

Monitoring

Deer exhibit both seasonal and annual variations in foraging behavior. During spring and summer, the animals can find abundant and high quality wood-lot forage and stay away from residential areas. The foraging opportunities become limited in the winter, so evergreen leaves and deciduous buds constitute an attractive diet. Deer approach populated centers in the winter months to feed off landscape plants at nurseries and golf courses. They are "browsers" rather than "grazers" and can render an entire nursery plantation unmarketable.

Control options

A number of options exist to try and prevent deer damage to landscape plants. One option is to hunt the animals that are feeding where not wanted. This approach is difficult to implement because of regulations, permits and the proximity of homes.

Sprays of repellent materials offer some relief where the deer pressure is light. Many products have been tested to limit wildlife damage: bars of soap, bags of human hair, blood meal and chemical products. Results have not been encouraging, as the success is measured in reduction but not the elimination of damage (Simpson and Kelsall, 1993). The repellents need to be reapplied regularly to cover new growth and replace the material washed away by the rain. They tend to lose their efficiency over time as the animals get used to the smell.

Another strategy is to present the deer with plants they find so undesirable they will limit their foraging to native plants growing in adjacent wood lots. Studies done in the United States around 1988 ranked a number of ornamental species in order of preference for the white-tailed deer (in Connecticut) and for the mule deer (in Utah). Table 4-10 list some of the plants compiled in the Utah study. Preferred plants can be planted to lure animals away from valued nursery stock, a method currently being researched with grain and forage crops in the Kootenays (East Kootenay Trench and Agriculture Wildlife Committee, 1991).

Other research indicates that deer damage will decrease as the distance from wood lots increases. Thus, on large sites, plant the nursery stock or the more valuable landscape plants away from the cover of woods and install undesirable plants close to the woods. Again, this approach may lose efficiency over time as the deer learn to walk by the undesired plants and go towards the more valued plants (McIvor and Conover, 1991).

Under high deer pressure, or where other methods fail, erecting a fence is the most certain method of protection. The costs depend on the size of the property and local prices of materials and labor. In Interior regions, woven wire fences should be 2.4 to 3.0 meters high (10 feet) on the high side of a slope, as determined deer can jump an 8-foot fence on a flat surface. In coastal areas, 1.8 to 2.4 meters (7 feet) may be sufficient. Solid wooden board or parcel fences may provide effective visual barriers to keep deer out of some areas.

Another option is to protect individual plants or areas. Chicken-wire cages around young plants and cylinders of wire fencing around larger specimens, along with a vocal watchdog in the yard during the evening, will help in saving valuable plants.

Table 4-10: The Western mule deer and its preferred landscape plants

High Preference Species	Low Preference Species
Abies balsamea	Acer platanoides
Berberis thunbergii	Betula spp.
Chaenomeles japonica	Cornus stolonifera
Cotoneaster dammeri	Crataegis spp.
Euonymus spp.	Fraxinus americana
Forsythia spp.	Ilex aquifolium
Juniperus chinensis	Lilium tigrinum
Juniperus spp.	Picea engelmannii
Juniperus tamariscifolia	Picea pungens
Lavandula spp.	Populus augustifolia
Narcissus spp.	Potentilla fruticosa
Phlox spp.	Pseudotsuga menziesii
Pinus mugo	Ranunculus spp.
Pinus sylvestris	Ribes grossularia
Pyracantha spp.	Wisteria spp.
Sedum spp.	Yucca spp.
Taxus cuspidata	
Thuja spp.	
Tulipa spp.	
Viburnum spp.	
Viola spp.	

Adapted from Austin, D.D. and A.B. Hash, "Minimizing Browsing Damage by Deer: Landscape Planning for Wildlife" cited in McIvor, D.E. and M.R. Conover, "Uninvited Guests: How to Keep Deer From Dining on Your Valuable Nursery Stock", *American Nurseryman*, September 15, 1991.

D) REFERENCES

- Adams, R.W. editor, "Handbook For Pesticide Applicators And Dispensers", Fifth Edition, Ministry of Environment, Lands and Parks, (Victoria, B.C.), 1988.
- Agrios, G.N., "Plant Pathology", Academic Press Inc. (San Diego, CA), 3rd Edition, 1988.
- Alex, J.F. and C.M. Switzer, "Ontario Weeds", Ontario Ministry of Agriculture and Food (Toronto, Ont), undated.
- Burrill, L.C. et al, "Pacific Northwest 1992 Weed Control Handbook", Oregon State University (Corvallis, OR), 1992.
- Barnett, Carol editor, "1993-93 Nursery Crop Production Guide For Commercial Growers", B.C. Ministry of Agriculture, Fisheries and Food (Victoria, B.C.), 1993.
- Bartlett, D. and M. Lanthier, "Non-Chemical Weed Control In High Density Orchards", ARDSA Project 11046, Integrated Crop Management Inc. (Okanagan Centre, B.C.), 1992.
- Berry, R.E., "Insects & Mites of Economic Importance in the Northwest", Oregon State University Book Stores, Inc. (Corvallis, OR), 1978.
- Bussiere, Hector. Ornamental Horticulturist (City of Victoria, B.C.) Personal Interview. July 12, 1993.
- Byers, R.E. and P.F. Scanion, "Keep Deer Away with Soap", *Fruit Grower*, October 1987.
- Carroll, D.P. and S.C. Hoyt, "Augmentation of European Earwigs (Dermaptera: Forficulidae) for Biological Control of Apple Aphid (Homoptera: Aphididae) in an Apple Orchard", *Journal of Economic Entomology*, 77: 738-740, 1984.
- Cowgill, W., "Fight Deer Damage", *Fruit Grower*, November, 1988.
- Crumb, S.E., P.M. Eide, A.E. Bonn, "The European Earwig", Technical Bulletin 766, U.S. Department of Agriculture (Washington D.C.), 1941.
- Daar, S., "Designing Weeds Out of Urban Landscapes", *The IPM Practitioner*, 15(8): 1-6, 1993.
- Daar, S., "IPM for the Black Vine Weevil on Ornamental Plants", *The IPM Practitioner*, 13(5-6): 1-5, 1991.
- Daly, Dan. Parks Department (Kitchener, Ontario). Personal Interview. July 27, 1993.
- Daughtrey, M.L., C.R. Hibben, G.W. Hudler, "Cause and Control of Dogwood Anthracnose in Northeastern United States", *Journal of Arboriculture*, 14(6): 159-164, 1988.
- Derr, J.F. and B.L. Appleton, "Herbicide Injury to Trees and Shrubs: A Pictorial Guide to Symptom Diagnosis", Blue Crab Press (Virginia Beach, VA), 1988.
- East Kootenay Trench and Agriculture Wildlife Committee, "An Integrated Use Action Committee", Fact Sheet, Cranbrook, B.C., 1991.
- Edwards, Linda. Integrated Crop Management Inc. (Okanagan Centre, B.C.) Personal Interview. July 22, 1993.
- Ellefson, C., T. Stephens, D. Welsh, "Xeriscape Gardening. Water Conservation for the American Landscape", Maxwell Macmillan Canada (Toronto, Ont.), 1992.
- Fisher, G. et all, "Pacific Northwest 1992 Insect Control Handbook", Oregon State University (Corvallis, OR), 1992.
- Foster, L, "Your Frost Dates and Climate Zone", in: "Gardening Techniques", Ortho Books (San Francisco, CA), 1984.
- Gerber, H.S. et al, "A Gardener's Guide to Pest Prevention And Control in the Home and Garden", Ministry of Agriculture and Fisheries (Victoria, B.C.), 1990.
- Gerber, H.S., N.V. Tonks, D.A. Ross, "Insect and Mite Pests of Ornamental Shrubs and Shade Trees of British Columbia", Ministry of Agriculture and Fisheries (Victoria, B.C.), 1983.
- Grant, J.A. and C.L. Grant, "Trees and Shrubs for Coastal British Columbia Gardens", Whitecap Books (Vancouver, B.C.), Second Edition, 1990.
- Ham, D.L. and J.R. Clark, "Maintaining Tree / Turf Associations: A Plant Health Care Approach", *Arborist News*, 2(3): 33-35, 1993.
- Hansen, A.J. and F.B. Stewart editors, "Gardening in the Okanagan", Okanagan Past and Present Society (Summerland, B.C.), 1976.
- Harris, R.W., "Arboriculture: Integrated Management of Landscape, Trees, Shrubs, and Vines", Prentice Hall Inc. (Englewood Cliffs, NJ), 2nd Edition, 1992.
- Hebda, Richard. Royal British Columbia Museum (Victoria, B.C.) Personal Interview. August 31, 1993.

- Hebda, Richard, "Native Plant of the Month: Thimbleberry", *The Island Grower*, June 1993.
- Herbst, B., "Going 'Organic", *Recreation B.C.*, Spring 1992.
- Herbst, B., Mimeographed Paper, Port Coquitlam, B.C., Spring 1991.
- Kluge, T., "Discouraging Deer Damage", in: "Urban Gardener" No. 14, Ministry of Agriculture and Food, (Summerland, B.C.), Oct / Nov 1983.
- Koehler, C.S., "Insect Pest Management Guidelines for California Landscape Ornamentals", University of California Cooperative Extension (Oakland, CA), 1987.
- Koepsell, P.A. and J.W. Pscheidt editors, "Pacific Northwest 1992 Plant Disease Control Handbook", Oregon State University (Corvallis, OR), 1992.
- Lacey, S. editor, "Lawns & Ground Cover", Pavilion Books Limited (London, England), 1991.
- McIvor, D.E. and M.R. Conover, "Uninvited Guests: How to Keep Deer From Dining on Your Valuable Nursery Stock", *American Nurseryman*, September 15, 1991.
- Nicholls, W., "Native ornamental plants on world stage", *Country Life in B.C.*, August 1993.
- Olkowski, W., S. Daar, H. Olkowski, "Common-Sense Pest Control", The Taunton Press (Newtown, CT), 1991.
- Pirone, Pascal P., "Diseases & Pests of Ornamental Plants", 5th Edition, John Wiley & Sons, Inc. (Toronto, Ont), 1978.
- Powlowski, R. et al, "The Development and Implementation of a Predator Based Control Program for the Pear Psylla, *Cacopsylla pyricola*, and Other Pear Pests", Integrated Crop Management Inc. and B.C. Fruit Growers' Association (Okanagan Centre, B.C.), July 15, 1993.
- Readman, J., "Soil Care and Management", The Henry Doubleday Research Association (Coventry, England), 1991.
- Retan, A.H., "European Earwig Prevention and Control", Extension Bulletin 1206, Washington State University (Pullman WA), 1987.
- Rhay, T., "An Ornamental Rose Garden Managed Without Insecticides or Fungicides", *The American Rose*, January 1990.
- Robinson, D.W., "Mulches and Herbicides in Ornamental Plantings", *Horticulture Science*, 23(3): 547-552, 1988.
- Shepherd, R.F., T.G. Gray, T.F. Maher, "Management of Black Army Cutworm", Information Report BC-X-335, Forestry Canada (Victoria, B.C.), 1992.
- Simpson, K. and J.P. Kelsall, "Options To Protect Crops From Damage By Deer In British Columbia", Keystone Bio-Research (White Rock, B.C.), prepared for Ministry of Agriculture, Fisheries and Food, Okanagan Valley Tree Fruit Authority, Ministry of Environment, Lands and Parks, British Columbia Federation of Agriculture, 1993.
- Stephen, Bill. IPM Coordinator (City of Vancouver, B.C.) Personal Interview. August 26, 1993.
- Taylor, L. and J. Newton, "Turf", in: "UBC Guide To Gardening In British Columbia", University of British Columbia (Vancouver, B.C.), 2nd Printing, 1991.
- Whitson, T.D. et al, "Weeds Of The West", Western Society of Weed Science and University of Wyoming, 1991.
- Williamson, J.F. et al, "Sunset Western Garden Book", Lane Publishing Co. (Menlo Park, CA), 1990.