Our Strawberries
Les Fraisiers
de chez nous

A description of over 170 strawberry cultivars including photographs of the plants, fruits, flowers, pollen and leaves.

Description de plus de 170 cultivars de fraisiers avec les photos des plants, fruits, fleurs, pollen et feuilles.
Our strawberries = Les fraisiers de chez nous

Text in English and French.
"A description of over 170 strawberry cultivars including photographs of the plants, fruits, flowers, pollen and leaves."

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1. INTRODUCTION

The strawberry cultivars grown across Canada were the same as those grown in the Northern United States until the 1930s (Darrow, 1966). The discovery in 1923 of the chance seedling, which became ‘British Sovereign’, changed this situation in British Columbia. This cultivar predominated in the Province from the 1930s until the early 1960s, about the same time as cultivars from the Eastern Canadian breeding program became important in the Maritimes and throughout Quebec and Ontario. Ironically, a cultivar from Washington State, ‘Northwest’, replaced ‘British Sovereign’. Subsequently, ‘Totem’ from the British Columbia program replaced ‘Northwest’ in the 1970s. ‘Totem’ remains the predominant cultivar in British Columbia and throughout the Pacific Northwest. It has been widely used as a parent in breeding programs in many parts of the world.

Several other cultivars introduced from the British Columbia program have had minor impact. ‘Agassiz’ introduced by Drs. J.A. Freeman and T. Anstey was briefly important in the late 1950s and early 1960s, and was noted for its winter hardiness. Dr. H. Daubeny then released ‘Sumas’ after ‘Totem’ and it has endured in a small way as a cultivar for early fresh market. Its soft, high quality fruit is susceptible to fruit rot. Plants are vigorous and have winter hardiness and some red stele resistance. Several recent releases, including ‘Whonnock’ and ‘Nanaimo’ have good fruit qualities but are only grown on a limited scale.

At the same time, the predominant cultivars all through Eastern Canada emulated from breeding programs in the region. These were ‘Redcoat’, ‘Cavalier’, ‘Guardsmen’, and ‘Grenadier’, all introduced in the 1960s by L.P.S. Spangelo (AAFC, Ottawa) and then ‘Vestar’ by Dr. C.L. Ricketson (Horticultural Research Institute of Ontario, Vineland) in 1967. ‘Redcoat’ rapidly found its way to many provinces due to its productivity and fruit quality. Since then, several breeding programs have been established across Canada in an attempt to develop locally bred cultivars resistant to major pests and diseases and adapted to our cold northern climate. The need for local tolerant or resistant cultivars is based on the presence and severity of local diseases and races specific to that region. Most of the current strawberry breeding programs try to incorporate one or multiple resistance genes and development of resistant cultivars is considered the best method of disease control. However, genetic resistance requires continuous effort, since new races of disease may develop due to the instability of single gene resistance or the misuse of pesticides to control the diseases.

2. IMPACT OF THE CANADIAN BREEDING PROGRAM

Canadian strawberry breeders have contributed significantly to the development of strawberry cultivars adapted to a wide range of environments from west to east. The fact that no one cultivar dominates across the country, reflects the regional adaptation of the strawberry. Nevertheless, all of the breeding programs have had common objectives, e.g. disease resistance, ease of harvest, high fruit quality, firm fruit, and a uniform, medium-red interior and glossy non-darkening red exterior with good shelf-life. Large sized fruit is also important for increasing harvest efficiency. Flavour, of course, is always a major consideration. Basically, color and flavour traits are what distinguish Canadian-bred cultivars from the ubiquitous California-type cultivars that continue to flood the Canadian markets.

Canada is fortunate to have some of the best growing conditions in the world for producing high quality, flavourful strawberry fruit in widely separated regions; starting in the west with coastal British Columbia, going east to southern Ontario and Quebec, and on to the Annapolis Valley of Nova Scotia (Table 1). Each region has unique problems but some are common to all regions, e.g. red stele root rot (Phytophthora fragariae var. fragariae), fruit rot (Botrytis cinerea), two spotted spider mite (Tetranychus urticae) and various species of weevils. Other problems appear to be more limited to certain regions, e.g. Verticillium wilt (Verticillium albo-atrum and V. dahliae) in Quebec and Ontario, winter damage more likely in Eastern Canada and various aphid-transmitted viruses more likely in British Columbia. The continuing success of the Nova Scotia cultivars is at least partially due to red stele resistance.
LEWIS E. AALDERS was a cytogeneticist in the small fruit breeding section of Agriculture and Agri-Food Canada, Atlantic Food and Horticulture Research Centre (AFHRC), Kentville, Nova Scotia. He was born in Kentville on July 19, 1933. He graduated and obtained his B.Sc. and M.Sc. at Acadia University in 1952 and 1953, respectively, and later obtained a Ph.D. from Cornell University in 1957. Dr. Aalders began work at the AFHRC, Kentville in 1953, conducting research related to the breeding of small fruit crops, including the strawberry. His work focused on an inbreeding program and a program of recurrent reciprocal selection with Dr. Craig. The production of an F1 hybrid variety that can be improved in a step-wise fashion by backcrossing was the aim of this work. Drs. Aalders and Craig introduced the variety ‘Acadia’ in 1965. Dr. Aalders also contributed to the development of several strawberry cultivars including: ‘Acadia’, ‘Bounty’, ‘Kent’, and ‘Micmac’.

DONALD L. CRAIG was the leader of the small fruit breeding section of AAFC, AFHRC, Kentville, Nova Scotia. He was born in Kentville on December 18, 1923. He graduated and obtained a B.Sc. in Agriculture from McGill University and later obtained a M.Sc. and Ph.D. from the University of New Hampshire in 1955 and 1959, respectively. Beginning in 1947, he was very active in the development of new strawberry varieties adapted to Eastern Canada and also worked on the development of new raspberry cultivars. Drs. Craig and Aalders introduced the first strawberry certification program in Canada. He also contributed in development of several strawberry cultivars including: ‘Acadia’, ‘Annapolis’, ‘Blomidon’, ‘Bounty’, ‘Cavendish’, ‘Cornwallis’, ‘Glooscap’, ‘Kent’, and ‘Micmac’.

ADAM DALEY obtained a B.Sc. and Ph.D. from Sheffield University, United Kingdom. His main interests are breeding, genetics and management of berry crops. During 1983 to 1997 he was active in the development of new strawberry cultivars and worked for the Horticultural Research Station in Simcoe, Ontario. Presently he is a professor in the Department of Plant Agriculture at the University of Guelph and is involved in breeding and management of berry crops. In management studies of all berry crops he seeks to reduce inputs and develop integrated pest management practices, and works to introduce extended season technologies. His breeding and genetics program seeks to develop new strawberry cultivars for the Ontario market. Genetic studies are focused on fruit quality, pest and disease resistance in strawberries and on understanding the factors involved in season extension and adaptability in strawberries and raspberries. Since 1983, he has contributed to the release of several strawberry cultivars, including ‘Governor Simcoe’, ‘G19’, ‘Mohawk’, ‘Secord’, ‘Selkirk’, ‘Settler’, ‘St. Williams’, ‘Scotland’, ‘Startyme’, ‘Sapphire’ and ‘Serenity’.

HUGH DABENNY was born on December 6, 1931 in Nainaimo, British Columbia. He received his B.S.A. and M.S.A in 1953 and 1955, respectively, from the University of British Columbia and his Ph.D. in Plant Breeding and Genetics from Cornell University, in New York. He has been affiliated with Agriculture and Agri-Food Canada since 1958, at Agassiz and then later in Vancouver. For more than 35 years he directed the strawberry and red raspberry breeding programs. In both breeding programs, Dr. Daubeney stressed broad germplasm bases and encouraged extensive mutational exchanges with other programs in the Pacific Northwest and throughout the world. He also has stressed the use of a diverse germplasm base in strawberry. Dr. Daubeney, in cooperation with plant pathologists and virologists, developed selection protocols and established inheritance patterns for important diseases of both raspberry and strawberry. He is a Fellow of the


1. INTRODUCTION

The second largest natural resource-based industry in Canada is the agricultural sector and horticultural production, and fruit crops play a major role (http://www.agr.gc.ca/misb/hort/home_e.php). Canada imports several fruits, including strawberry because of its short growing season. In northern areas, the season is especially short and there is a lack of adapted cultivars suitable for these climates. Importation includes more than 40,000 tons of strawberries annually at a cost of more than 9 million Canadian dollars, with fruit received from the USA, Chile and Mexico (Statistics Canada, 2003). Breeding cultivars adapted to local conditions, especially for regions like northern Quebec and Ontario where the winter climate is harsh but the summers are excellent for strawberry culture, could provide opportunity for local production. Quebec and Ontario are the leading provinces in strawberry production with over 15,000 tons produced annually (Table 1).

Table 1. Trends in Canadian strawberry production (metric tonnes) and farm gate value (FGV, $ CAD) since 1996.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Ontario</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>8,399</td>
<td>9,081</td>
<td>8,829</td>
<td>8,981</td>
<td>7,258</td>
<td>7,450</td>
</tr>
<tr>
<td>FGV</td>
<td>14,073</td>
<td>17,350</td>
<td>17,430</td>
<td>17,360</td>
<td>17,300</td>
<td>17,500</td>
</tr>
<tr>
<td>Quebec</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>10,433</td>
<td>10,641</td>
<td>9,798</td>
<td>9,571</td>
<td>9,886</td>
<td>8,959</td>
</tr>
<tr>
<td>FGV</td>
<td>15,180</td>
<td>16,375</td>
<td>15,050</td>
<td>15,950</td>
<td>15,350</td>
<td>16,000</td>
</tr>
<tr>
<td>Canada</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Production</td>
<td>28,571</td>
<td>26,861</td>
<td>27,329</td>
<td>26,350</td>
<td>24,063</td>
<td>23,737</td>
</tr>
<tr>
<td>FGV</td>
<td>48,417</td>
<td>49,196</td>
<td>49,705</td>
<td>49,885</td>
<td>49,325</td>
<td>48,410</td>
</tr>
</tbody>
</table>

Source: Statistics Canada

In recent years, strawberry has had the fourth highest farm gate value (FGV) for fruit, after apple, blueberry and grape (Table 2). Annual FGV has remained relatively flat since 1995 at approximately $50 million. “Pick-your-own” operations are popular when close to urban areas. Strawberries are grown commercially in every province, however, Quebec (38%) and Ontario (31%) have the largest production followed by British Columbia (15%) (Table 1). The area of production slowly increased from 1991 to 1995, but retracted to about 5,000 hectares in 1996, and has risen slightly to 5,400 hectares in 2001. There is very little processing of Canadian strawberries.

Table 2. Major horticultural fruit products (over $35 million farm gate value) compared to strawberry production.

<table>
<thead>
<tr>
<th>Products</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
<th>2001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apples</td>
<td>148</td>
<td>209</td>
<td>197</td>
<td>155</td>
</tr>
<tr>
<td>Blueberries</td>
<td>57</td>
<td>113</td>
<td>104</td>
<td>85</td>
</tr>
<tr>
<td>Grapes</td>
<td>55</td>
<td>70</td>
<td>63</td>
<td>72</td>
</tr>
<tr>
<td>Strawberries</td>
<td>50</td>
<td>50</td>
<td>49</td>
<td>48</td>
</tr>
</tbody>
</table>

Source: Statistics Canada

Canada’s imports of fresh and processed strawberries have increased steadily reflecting the increased use of fruit products by consumers (Table 3). Fresh imports were valued at $122 million in 2001, a sharp increase of 16% over 1999. Frozen strawberry imports reached a record high of $26 million in 1999, but decreased to $23 million in 2001. Both fresh and frozen imports originate mostly from the USA and Mexico. Canadian exports of fresh and processed strawberries are relatively small and accounts for about $1 million in 2001 (http://www.agr.gc.ca/misb/hort/home_e.php).
1. INTRODUCTION

The commercial strawberry, *Fragaria x ananassa* Duchesne in Lamarck, has a very narrow germplasm base (Hancock et al., 1993; Sjulin and Dale, 1987), even though its progenitor species have an extensive geographical range across North and South America. It originated about 250 years ago when a few New World clones of *F. chiloensis* and *F. virginiana* accidentally hybridized in European gardens (Wilhelm and Sagen, 1974). Thomas A. Knight began the systematic breeding of strawberries in England in 1817, but he had only a small number of native and cultivated clones at his disposal. Likewise, North American genetic improvement began in the mid-1800s with a restricted group of European *F. x ananassa* cultivars, South American *F. chiloensis* (L.) Miller and North American *F. virginiana* Miller (Darrow, 1966). The cultivars originating from this background played the predominant role in most public and private breeding programs for the next 100 years.

The majority of the genes in modern North American cultivars still come from only a handful of nuclear and cytoplasmic sources (Sjulin and Dale, 1987; Dale and Sjulin, 1990; Hancock and Luby, 1995), even though numerous germplasm collection trips have been undertaken in the Americas (Cameron et al., 1993; Dale et al., 1992; Darrow, 1957; Hancock et al., 1990; Luby et al., 1991). This paper describes the amount of diversity found in the *Fragaria* of the Americas, and catalogues some of the most promising breeding parents. It is hoped that this information will stimulate the broader utilization of the wild germplasm.

2. THE AMERICAN STRAWBERRY SPECIES

There are four native strawberry species found in North and South America: the diploid *Fragaria vesca* L., which has 14 chromosomes, and the octoploids *F. chiloensis* (L.) Duch., *F. virginiana* Duch. and *F. x ananassa*, which have 56 chromosomes (Staudt, 1999).

There are three subspecies of the wood strawberry, *F. vesca*, found in North America (Staudt, 1962): 1) ssp. *americana* (Porter) - woods of eastern North America to British Columbia, 2) ssp. *bracteata* - woods of western North America, and 3) ssp. *californica* - California. Several ecotypes have been described within ssp. *californica*, including headland scrub, coastal forest and Sierran forest (Hancock and Bringhurst, 1978). All of these subspecies are hermaphroditic and self-fertile, except for ssp. *bracteata*, which has both hermaphrodites and occasional females (Staudt, 1989).

There are four subspecies of the beach strawberry, *F. chiloensis* (Staudt, 1962): 1) ssp. *lucida* (E. Vilm.) - coast of Pacific ocean from Queen Charlotte Island to San Luis Obispo, California, 2) ssp. *pacificar* Staudt - coast of Pacific ocean from Aleutian Islands to San Francisco, California, 3) ssp. *sandwicensis* (Decaisne) - Hawaii, and 4) ssp. *chiloensis* (L.) Duch. - beaches and mountains of South America. Two forms of this subspecies are recognized, the cultivated *F. chiloensis* ssp. *chiloensis* *F. chiloensis* and the native *F. chiloensis* ssp. *chiloensis* *F. patagonia*. Recent morphometric and RAPD analyses of interspecific variation in *F. chiloensis* have indicated that ssp. *lucida* and *pacificar* might intergrade too much to be considered separate subspecies, but ssp. *sandwicensis* and *chiloensis* are distinct (Catling and Porebski, 1998; Porebski and Catling, 1998). The major characteristics used to separate the subspecies were hair length, leaflet size, plant color, petal number and whether the hairs on the leaf stalk were ascending or spreading. Hair orientation was the only reliable way to distinguish ssp. *lucida* from *pacificar*.

Several ecotypes of *F. chiloensis* have been identified in North America. Distinct dune, coastal strand, headland scrub and woodland-meadow types are found in California (Hancock and Bringhurst, 1979b). They are distinguished primarily by flower number, leaf width, leaf biomass, runner width and resistance to salt and drought stress. The woodland-meadow types may be stabilized hybrid derivatives of *F. chiloensis* *F. virginiana*.

Wild populations of *F. chiloensis* are either dioecious, gynodioecious or perfect flowered, depending on geographical location. North American *F. chiloensis* are primarily dioecious, with staminate plants being about 10% more common than pistillate (Hancock and Bringhurst, 1979a, 1980). In some cases, apparent males are polygamodioecious and bear a few early fruit. Small numbers of highly fertile hermaphrodites have been found in California at Año Nuevo and Pigeon Point, and in the northern islands off the coast of British Columbia. In Chile, *F. chiloensis* is largely gynodioecious, as most wild plants are either pistillate or...
1. INTRODUCTION
There are two major genebanks in North America that preserve *Fragaria* genetic resources. One is located in Harrow, Ontario, Canada, while the other is in Corvallis, Oregon, United States. Both are under the auspices of the federal government organizations in their respective countries. The Canadian Clonal Genebank (CCG) is under the jurisdiction of Agriculture and Agri-Food Canada (AAFC) while the National Clonal Germplasm Repository (NCGR) is part of the United States Department of Agriculture (USDA), Agricultural Research Service (ARS), National Plant Germplasm System (NPGS).

2. PROGRAM AND MANDATE

Canada
Plant Gene Resources of Canada was created in 1970 to serve as the national crop genetic resource system for Canada. Because the Canadian government recognized that the worldwide gene pools of crop plants and their wild relatives were being increasingly and seriously eroded, it acted to protect and preserve the vast genetic diversity for future generations. In 1989, the CCG was officially established at the existing Smithfield Experimental Farm in Trenton, Ontario. In 1996, Smithfield closed as a result of program review and consolidation, and the Clonal Genebank was transferred to Harrow, Ontario. The mandate of the CCG is to protect and preserve the genetic diversity of Canadian fruit crop plants and their wild relatives. To do this, plant genetic resources are acquired, maintained, evaluated and documented in order to provide the fundamental genetic building blocks for crop variety development and plant genetic studies nationally and internationally. The genera maintained include: *Asimina*, *Fragaria*, *Malus*, *Prunus*, *Pyrus*, *Ribes*, *Rubus*, *Sambucus*, and *Vaccinium*.

United States
The United States national plant germplasm system (NPGS) is a network of cooperating institutions, agencies, and research units in the federal, state, and private sectors (Shands et al., 1989). The U.S. Congressional Agricultural Marketing Act of 1946 authorized working collections to be established at four federal regional plant introduction stations (RPIS) and at Fort Collins, Colorado. Subsequently congressional funding was increased to establish ten NCGRs, to preserve clonally or vegetatively propagated crops. The NCGR-Corvallis was established in 1981 to preserve *Corylus, Fragaria, Humulus, Mentha, Pyrus, Ribes, Rubus, Vaccinium*, and other specialty crops.
Up to the present day, considerable progress has been made in understanding the cultivated strawberry (*Fragaria x ananassa* Duch.) and many cultivars have been introduced. It is not the intention to review this progress, as there have been several outstanding reviews published (Hancock *et al.*, 1990; Hancock *et al.*, 1996; Hancock, 1999; Faedi *et al.*, 2002). However, at the present time, there are several major influences that impact upon strawberry breeding. These will be discussed and then those areas thought to become major areas of progress or contention in North America over the next decade will be covered.

1. **INFLUENCES THAT IMPACT UPON STRAWBERRY BREEDING**

Although there are many traditional influences that define the goals of our breeding programs, there are several movements that have developed in the latter part of the 20th century, which will have tremendous impact on the way we do business in the future. We are just beginning to feel the impact of biotechnology and at least some of the techniques developed are being and will be used to develop new strawberry cultivars. Research into the nutritional value of fruits and vegetables is starting to show the benefits to human health.

Concerns about the effect of agriculture on the environment have been with us for a while but several aspects are of more topical concern. There is relentless pressure to reduce or eliminate the chemicals used to control pests and diseases, which will inevitably change the way we view plant resistance to pathogens. Soil fumigants appear to be especially vulnerable, and the elimination of methyl bromide as a fumigant will impact the strawberry industry, particularly in California and Florida. Recently the issue of water use and quality has risen to the North American public’s consciousness. Linked to this are nutrient management practices with the leaching of nutrients, especially nitrogen and phosphorus probably being of greatest concern.

Also, there is a gradual change taking place over where and how strawberries are grown in North America. California has been the dominant force in the North American strawberry industry for the last half century, but urbanization, over-production and the elimination of methyl bromide may give other areas of North America a chance to change the status quo. In the North, the expansion of hill systems together with the use of day-neutral cultivars are allowing these areas to extend the harvest season so that they can compete more effectively against California and other production areas in the world.

In Europe and elsewhere in the world, much of the strawberry crop is now grown under some form of protected environment structure, greenhouses or large tunnels. Just how much impact this form of culture will have on production in North America remains to be seen. With the present prices for strawberries, protected culture is not economically feasible, but that scenario could easily change.

2. **FRUIT QUALITY**

Many characteristics affect fruit quality, but this chapter will concentrate on three aspects; fruit firmness, nutritional value and flavour. Fruit firmness is generally considered to be the product of flesh firmness and skin strength, and both are often correlated (Ourecky and Bourne, 1968) and are greatly influenced by temperature and humidity during fruit development and ripening (Hancock *et al.*, 1996). Fortunately, there are now cultivars that can be considered to have firm flesh with good skin strength (Chapter 11).

There are two important points in regards to firmness. Firstly, it is thought that regional climatic differences lead to different breeding priorities for firmness. From many years of field observations of cultivars from different parts of the world, the author has concluded that although breeders in different regions breed for firm fruit, the results will be different because fruit firmness varies with temperature and strong skin protects the fruit better in high light intensities. Consequently, breeders in hot
1. INTRODUCTION

Sustainable production is a term that emerged in agriculture during the past 20 years. Although an exact definition of sustainable agriculture is elusive, there is general agreement on three requirements: the system is economically viable, environment health is maintained while natural resources are conserved, and benefits accrue to society. Of course, one can debate the relative benefits of various practices and argue that no system can be perfectly sustainable. However, it is useful to consider certain guiding principles when developing any production system to help slow the decline of our natural resource base and erosion of farming communities.

Aspects of a sustainable strawberry production system could include the following:

1. Benefits to the producer must exceed costs,
2. Profit, alone, is not the sole guiding principle,
3. Products used in the production of strawberries should be renewable or recyclable, not used faster than they can be regenerated, not cause environmental damage during their manufacture, and not cause environmental damage off-site after they are used,
4. On-site environmental damage should be repairable at the time strawberry production ceases at that location, and
5. The production system should do no harm to, but should benefit, local communities of people.

2. PRODUCTION PRACTICES

Growing strawberries involves many practices, some of which have a major impact on resource use, soil quality, and productivity. Many good references exist (Childers, 2003; Craig, 1976; Craig, 1979; Dale et al., 2000; Evans et al., 1988; Pritts and Handley, 1998; Sorensen et al., 1997a; Sorensen et al., 1997b; Strand, 1993). However, certain decisions are much more significant in their impact than others.

2.1. Selecting a Production System

Strawberries are grown in several different production systems, and each has advantages and disadvantages (Table 1). The most commonly used system in the world is an annual system in which conditioned plants are transplanted into fumigated soil through plastic in the fall and fruited in spring. Although this system is extremely productive and easy to manipulate, critics have pointed out that this system has significant environmental impacts such as reliance on annual fumigation, annual plastic application and disposal, transportation of conditioned plants across long distances, high planting costs, and a requirement for large amounts of water during establishment. Specialized equipment is also required, such as a bed maker, plastic layer, and fumigator.

In contrast, perennial systems do not appear to have such a large environmental impact and require less specialized and less costly inputs and equipment. However, these perennial systems are generally less productive and are more difficult to harvest. Similarly, strawberries grown in desert climates with lower humidity will require few pesticide applications, yet may require very large amounts of water to irrigate and energy to cool and transport fruit to market. Herein lies the difficulty in assessing sustainability. Certain guiding principles may begin to conflict with others, so one must use good judgment and consider impacts on the entire ecosystem and human communities when striving for sustainability.
3.2. Leather Rot

Leather or crown rot is caused by the fungus *Phytophthora cactorum*. It occurs in most temperate regions of the world on a wide variety of plants. Infection is favoured by warm, wet weather and poorly drained soil. The fungus attacks berries in the field at all growth stages. Fruit rot occurs when the berries come in contact with the soil. The pathogen may also cause a serious crown rot, which can develop along with fruit rot.

**Symptoms.** Leather rot symptoms vary depending on fruit stage. On immature fruit, symptoms begin as brown to dark brown spots that remain firm. The spots expand rapidly and cover the entire fruit. Ripening fruit clusters that are touching the ground in standing water after prolonged warm rains suddenly (in 1 to 2 days) turn grey-brown and become mushy. The fruit stems often become rotted. The infected fruit appear dark and leathery in texture, inside and outside. Mature fruit may become soft and dull pink to lilac, or may remain a normal color. When the fruit is split open, the vascular system of the fruit is darkened and shows up as dark streaks radiating from the fruit core outward. Infected fruit have a characteristic bad taste. A white fuzzy growth may appear on the fruit if conditions are moist.

**Management.** The fungus *Phytophthora cactorum* lives in the soil. When weather conditions are warm and rainfall is abundant, the pathogen releases its spores (zoospores) into the soil. These infested soil particles and zoospores are dispersed onto the fruit by splashing rain or irrigation water. Wet weather and temperatures of approximately 15 to 27°C favour this disease. It can progress quickly when conditions are favourable, causing huge losses in only a few days. Mulching, which keeps the fruit off the ground, will help minimize rain splash and control leather rot. Mulching with straw rather than plastic prevents the berries from sitting in water. This disease is worse in wet situations, so plant in well-drained soil and avoid compacting the soil around the plants. Plant narrow rows and space plants widely within the row to keep the canopy dry. Plant in an area with good air circulation and control weeds to improve air circulation. Irrigate in the morning so that leaves can dry quickly. There are no fungicides recommended for the control of leather rot, however, fungicides used to control red steel will control leather rot.

3.3. Anthracnose

Anthracnose is caused by the fungus *Colletotrichum acutatum*. The disease could be a problem if the weather in the spring is very warm and it is more severe in day-neutral or late bearing varieties.

**Symptoms.** The fungus infects stolons, petioles, fruit and leaves. Small dark lesions appear on the stolons and petioles in the summer. These are girdled, killing the leaves and unrooted daughter plants. The fungus grows from the infected petioles and
MAJOR ARTHROPOD PESTS AND POLLINATORS
OF STRAWBERRY IN QUEBEC

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1. INTRODUCTION

2 PESTS OF BUDS, FLOWERS AND FRUIT
2.1. Tarnished Plant Bug, Lygus lineolaris P. de B. (Hemiptera: Miridae)
2.2. Strawberry Bud Weevil, Anthonomus signatus Say (Coleoptera: Curculionidae)
2.3. Slugs

3 PESTS OF FOLIAGE
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3.2. Cyclamen Mite, Phytonemus pallidus (Banks) (Acarina: Tarsonemidae)
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3.5. Amphipoea interoceana (Sm.) (Lepidoptera: Noctuidae)
3.6. The Leafroller Complex
3.6.1. Olethreutes olivaceana (Fern.) (Lepidoptera: Olethreutidae)
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3.7. Aphids (Homoptera: Aphidae)
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4 PESTS OF ROOTS
4.1. June Beetle (white grubs), Phyllophaga spp. (Coleoptera: Scarabaeidae)
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4.3. Strawberry Root Weevil, Otitorhynchus ovatus (L.) (Coleoptera: Curculionidae)
4.4. Strawberry Rootworm, Paria fragariae Wilcox (Coleoptera: Chrysomelidae)
4.5. Cutworms (noctuid moths), (Lepidoptera: Noctuidae)
4.6. Millipede, Ophyiulus pilosus (Diplopoda)

5. INSECT POLLINATORS

1. INTRODUCTION

Several arthropods (including insects and other organisms that are closely related taxonomically) attack strawberry and can cause significant losses. The best control strategy begins with a knowledge of the enemies. This chapter will begin with a discussion of the most important pests, namely pests of buds, flowers and fruit. It will then examine pests of foliage and, lastly, pests of roots. Although the information in this chapter is focused on Quebec, it may be applicable to other strawberry producers throughout northeastern North America.

Strawberry production has particular requirements in terms of protection. In the first year following transplanting, fruit production is poor and, as a result, producers take few protection measures. In the second year, fruit production peaks, as do the risks posed by insects. In the third year of production, the yield of strawberries is somewhat lower, but is worth picking under certain conditions, depending on the producer’s decision. In terms of protection, the risks are essentially the same as those of the second year. However, weeds can invade the strawberry field in the third year, in which case producers may decide to halt production. Most producers establish new strawberry fields frequently, giving them the option of carrying out rotations; an extremely important cultural control method from an insect and weed perspective. This option is not available to growers of other fruits, such as apples and peaches and small fruits, such as raspberries and blueberries.

2. PESTS OF BUDS, FLOWERS AND FRUIT

2.1. Tarnished Plant Bug, Lygus lineolaris P. de B. (Hemiptera: Miridae)

Description. Adult tarnished plant bugs are brown and measure 6 mm in length. The pale green nymphs look like the adults but are smaller and do not have wings. Their more rapid movements distinguish them from aphids, which are slow-moving and not highly mobile. The tarnished plant bug has piercing-sucking mouth parts. It moves about frequently in the strawberry field.

Life cycle. The tarnished plant bug is a pest of several crops, including strawberry, apple, alfalfa and potato. It has several generations per year and moves from one crop to another in search of suitable hosts. The adult overwinters in plant debris, not necessarily in the strawberry fields. The first adults can be seen in the fields in mid-May during the development of the flower
Cycle vital. La punaise terne se nourrit sur plusieurs plantes-hôtes dont le fraisier, le pommier, la luzerne et la pomme de terre. Elle effectue plusieurs générations par année et se déplace d'une culture à l'autre pour se nourrir sur un hôte propice. L'adulte hiverne dans les débris végétaux et donc, pas nécessairement dans la fraisière. En fraisière, on peut observer les premiers adultes dès la mi-mai lors du développement des hampes florales. La date d'apparition des punaises ternes au printemps dépend des conditions météorologiques et des cultivars de fraisier. On peut occasionnellement observer des adultes se nourrissant sur la fleur. Les femelles pondent leurs œufs dans les hampes florales et il est difficile de les détecter. L'éclosion des œufs de la première génération coïncide avec la formation des premiers fruits verts.

Ce sont surtout les larves de la punaise terne qui, en se nourrissant sur le fruit, provoquent des malformations caractéristiques. Les fraises attaquées sont petites et dures. Leurs achènes sont développés (grandeur maximale) et aggrégés. Par contre, chez les fruits mal pollinisés les achènes sont aussi aggrégés mais petits.

Lutte. L'élimination de mauvaises herbes (servant de plante-hôte alternative au fraisier) dans la fraisière et dans le voisinage immédiat contribue certainement à prévenir les dommages causés par cet insecte. On peut synchroniser les traitements chimiques d'après les stades phénologiques du fraisier ou mieux, dépister les insectes et effectuer des traitements en fonctions d'un seuil d'intervention de 0.15 larve par 100 frappes. La lutte pneumatique a été étudiée comme étant une alternative aux insecticides de synthèse. Elle n'est cependant pas pratiquée à l'échelle commerciale.

2.2. L'anthonome de la fleur du fraisier, *Anthonomus signatus* Say (Coleoptera: Curculionidae)

Description. L'adulte est un coléoptère noirâtre, d'environ 3 mm de longueur qui possède un long bec. Ses ailes sont dures. La larve ressemble à un vers blanc crème, n'a pas de pattes et est à peine plus grosse que l'adulte.

Cycle vital. L'anthonome a une génération par année et attaque plusieurs cultures fruitières dont le fraisier, le framboisier, le bleuetier et la vigne. Il passe l'hiver à l'état adulte dans les débris végétaux accumulés dans la fraisière ou ailleurs. Les adultes sont actifs tôt au printemps et apparaissent généralement au stade du bouton vert. L'adulte se nourrit du pollen des fleurs et perfore parfois les pétales. La femelle insère généralement un œuf par réceptacle. Elle gruge alors le pédoncule, ce qui cause le dessèchement et la chute de la fleur. La larve se développe dans les bourgeons tombés sur le sol. La génération d'été émerge au début de juillet et cause apparemment peu de dommages économiques à cette époque. On peut aussi avoir recours à un modèle de prédiction de l'abondance des adultes.

Lutte. L'anthonome migre peu et ses dommages sont conséquemment moins importants en première année de production dans une fraisière établie après une rotation. Les populations augmentent généralement avec les années dans une même fraisière. Les dommages de ce ravageur sont non seulement variables, mais aussi imprévisibles. On peut synchroniser les traitements...
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1. INTRODUCTION

Strawberries are one of the most perishable fruit crops and are essentially fully ripe at harvest. They have a high rate of metabolism and will destroy themselves in a relatively short time, even without the presence of decay-causing pathogens. The structure of the strawberry makes it susceptible to deterioration. It has a thin, tender skin that is easily damaged. The achenes are easily torn away and the flesh is soft, due to high water content, making it very susceptible to bruising and crushing. Any injury can invite an attack by decay-causing pathogens, to which this berry is very vulnerable. Deterioration of ripe strawberries is enhanced by high fruit temperature, which hastens metabolic activities, decay development, and internal breakdown. Delivery of high quality fruit to the consumer depends on the care taken by the various handlers. Damage may occur at every step in the handling system, from grower to retailer, but may not become apparent until later in the marketing system.

2. MATURITY AND HARVESTING

The harvest date is determined based on berry surface color. All berries should be harvested near full ripe (>3/4 red color), as eating quality does not improve after harvest. Appearance (color, size, shape, and freedom from defects), firmness, flavor (soluble solids, titratable acidity, and flavor volatiles), and nutritional value (vitamin C) are all important quality characteristics. For acceptable flavor, a minimum 7% soluble solids and/or a maximum 0.8% titratable acidity are recommended (Mitcham, 2003).

Strawberries have a relatively high rate of respiration (50-100 mL of CO₂ per kg per hour at 20°C) and thus are highly perishable. They produce very little ethylene (<0.1 ppm per kg per hour at 20°C) and do not respond to exogenous ethylene by stimulation of the ripening processes. Removal of ethylene from storage air may reduce disease development in all berries. Strawberries are usually hand harvested and field packed. Berries are harvested with the calyces attached and must be held loosely in the hand to avoid bruising injury and discoloration. The strawberries must be handled with care and placed gently into the container, not dropped into it. Harvest should be as frequent as needed to avoid over-mature berries. Fruit should be sorted carefully, to discard any fruit with fungal lesions or injuries (cuts, bruises, torn calyces, etc.). Harvesting, sorting, and packing are done simultaneously in the field.
STRAWBERRY DESCRIPTIONS

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1. FORMAT

2. DIAGRAMS

2.1. Fruit
   2.1.1. Fruit features
   2.1.2. Classification of strawberry fruit predominant shape
   2.1.3. Classification of strawberry fruit band without achenes
   2.1.4. Classification of strawberry fruit tip shape
   2.1.5. Classification of strawberry fruit calyx
   2.1.6. Classification of strawberry fruit neck size
   2.1.7. Classification of strawberry fruit achene position

2.2. Leaf
   2.2.1. Classification of strawberry terminal leaflet length/width ratio
   2.2.2. Classification of strawberry leaflet base
   2.2.3. Classification of strawberry leaflet teeth shape

2.3. Flower
   2.3.1. Classification of strawberry calyx diameter relative to petals
   2.3.2. Classification of strawberry flower petals spacing
   2.3.3. Classification of strawberry petal length/width ratio

2.4. Plant
   2.4.1. Classification of strawberry plant growing habit

3. STRAWBERRY DESCRIPTIONS IN ALPHABETICAL ORDER

3.1. June bearing
3.2. Day-neutral or everbearing
3.3. Ornamental
3.4. Other species

1. FORMAT

The name most commonly used to describe a cultivar is shown at the top followed by other common names if they exist (in brackets). The description of each cultivar normally begins by stating its origin. This includes the name of the country and/or the city where it was first released, the year in which it was introduced and the person(s) who either released, named, found or contributed to the commercialization of the cultivar. The parentage is given by stating the female and male parent in that order. The fruit description includes its size and shape, skin color, firmness and other collected fruit characteristics, e.g. flesh color, texture, juiciness, flavor and end use.

Several diagrams, including the fruit, leaf, flower and plant, have also been sketched based on the information that we had in our database or obtained from the Plant Breeder’s right office (ref.) to make it easy to understand the terms used to describe each cultivar. The season of ripening is provided and the ability of the fruit to survive in storage, as well as a legend to visualize the ripening season. General plant characteristics in regards to hardiness, form, productivity and vigor are also described. Susceptibility to diseases and disorders is provided, followed by general comments regarding each cultivar. A legend was also added when the cultivar was susceptible to all or at least one leaf, fruit or root disease.

The following symbols are used to identify cultivars with special characteristics where applicable:

Origin

Belgium  Canada  Denmark  England  Finland  France  Germany

Italy  Netherlands  Poland  Russia  Sweden  USA
3.1. June bearing

3.1. Fraisiers conventionnels
ACADIA
ACADIA

Origin: D.L. Craig, L.E. Aalders, Agriculture and Agri-Food Canada, Kentville, Nova Scotia. Introduced in 1964. Redcrop x Sparkle. Fruit: attractive, large in early harvests, medium size later on, conical, uniform, medium-light red, glossy, achenes are even with surface or slightly sunken; flesh: medium red, moderately firm, fine-grained, no core; flavour: excellent, slightly acid; end use: good for eating fresh, fair for frozen packs; ripening: mid-season to late, 2-3 days before Sparkle. Plant: medium size to large, upright, extremely vigorous, productive, good runner production. Diseases: susceptible to leaf spot, fairly resistant to verticillium wilt and powdery mildew.

Local performance
Fruit: secondary fruit are large, conic to bi-conic, red, glossy, band without achenes is narrow to medium, calyx segments are level, calyx has medium adherence to fruit, achenes are slightly sunken, very tender skin; flesh: 100% medium red, medium firmness; flavour: moderately pleasant, average sweetness, medium-weak acidity, only slightly aromatic, a bit bland. Plant: vigorous, medium density, fairly good runner production, upright; flowering: inflorescences are beneath to level with the foliage, fruiting trusses are medium length and semi-erect at first harvest. Diseases: fairly susceptible to leaf scorch.

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Performance locale
Fruit : fruit cadet gros, conique à bi-conique, rouge, luissant, à zone sans akènes étroite à moyenne, à calice plat moyennement facile à enlever, à akènes légèrement enfoncés, à peau très tendre; chair : 100% rouge moyen, moyennement ferme; saveur : moyennement agréable, moyennement sucrée, à acidité faible-moyenne, à peine aromatique, un peu fade. Plante : vigoureuse, dressée, moyennement dense, à production de stolons assez bonne; floraison : inflorescences portées plus bas que le feuillage ou au même niveau, grappes de longueur moyenne, demi-dressées à la première cueillette. Maladies : fraisier assez sensible à la tache pourpre.
ANAPOLIS

Origin: D.L. Craig, A.R. Jamieson, K.A. Sanford, N.L. Nickerson, Agriculture and Agri-Food Canada, Kentville, Nova Scotia. Introduced in 1984. K74-5 (Micmac x Raritan) x Earliglow. Fruit: primary fruit are large, conic and have reflexed calices, secondary fruit are medium size, globose to globose-conic with clasping calices, light red, glossy, calyx moderately difficult to remove; flesh: medium red, moderately firm; flavour: good; end use: good for fresh markets and frozen packs; ripening: very early to early. Plant: winter hardy in Atlantic Canada, medium density, vigorous, good but not excessive runner production, good productivity; flowering: early, medium length scapes. Diseases: very susceptible to powdery mildew, susceptible to botrytis fruit rot, intermediate resistance to verticillium wilt, resistant to races A-4, 6 and 7 of red stele. Other: tested as K78-6, sensitive to terbacil, picks easily.

Local performance
Fruit: secondary fruit are medium-large to large, globose-conic or cordate, red, glossy, band without achenes is very narrow to narrow, calyx segments are reflexed, hard to hull, achenes are sunken; flesh: 95% medium red, medium firmness; flavour: good, medium sweet, medium-strong acidity. Plant: vigorous, medium density, good runner production, globose habit, very low yield: flowering: inflorescences are beneath the foliage, fruiting trusses are medium length and semi-erect at first harvest. Diseases: moderately susceptible to leaf scorch.


Performance locale
Fruit : fruit cadet moyen-gros à gros, conique-globuleux ou cordiforme, rouge, luisant, à zone sans akènes très étroite à étroite, à calice réfléchi difficile à enlever, à akènes enfoncés; chair : 95% rouge moyen, de fermeté moyenne; saveur : bonne, moyennement sucrée, àacidité moyenne-forte. Plante : vigoureuse, moyennement dense, à bonne production de stolons, à port globuleux, à rendement très faible; floraison : inflorescences portées plus bas que le feuillage, grappes de longueur moyenne, demi-dressées à la première cueillette. Maladies : fraisier moyennement sensible à la tache pourpre.
BEAVER EARLY
BEAVER EARLY

Origin: J. Davidson, Agriculture and Agri-Food Canada, Beaverlodge, Alberta. Introduced in 1989. Cavalier x Protem. Fruit: fruit size falls off abruptly, conic to obconic, medium red, glossy; flavour: excellent, well balanced; ripening: 10-24 days before Protem. Plant: hardier than Protem which is very hardy, vigorous, runners freely, yields 2 to 3.5 times more than Protem. Other: tested as Selection 6948.

Local performance
Fruit: secondary fruit are medium size to medium-large, globose-conic to conic, red to dark red, glossy, band without achenes is very narrow to narrow, calyx segments are level to slightly reflexed, easy to hull, achenes can be sunken or level with the surface; flesh: 50-80% light to medium red, soft; flavour: pleasant, a bit aromatic, average acidity and sugar; ripening: very early. Plant: vigorous to very vigorous, good runner production, upright habit, dense matted row; flowering: inflorescences are beneath to level with the foliage, fruiting trusses are medium length and almost prostrate at first harvest. Diseases: moderately susceptible to leaf scorch.

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Performance locale
Fruit : fruit cadet moyen à moyen-gros, conique-globuleux à conique, rouge à rouge foncé, luisant, à zone sans akènes très étroite à étroite, à calice plat à légèrement réfléchi facile à enlever, à akènes enfoncés ou affleurants; chair : 50-80% rouge pâle à rouge moyen, tendre; saveur : agréable, un peu aromatique, moyennement acide, moyennement sucrée; maturation : très hâtive. Plante : vigoureuse à très vigoureuse, à bonne production de stolons, à port dressé, formant des rangs nattés denses; floraison : inflorescences portées plus bas que le feuillage ou au même niveau, grappes de longueur moyenne, presque étalées à la première cueillette. Maladies : fraisier moyennement sensible à la tache pourpre.
DEM ER LAND
DEMERLAND

Local performance
Origin: Station Fruitière et Maraichère, Grand-Manil, Gembloux, Belgium. Fruit: secondary fruit are medium-small to medium size with some large fruit, short-wedge to globose-conic, light red to red, moderately glossy, band without achenes is narrow to medium, calyx segments are mainly reflexed with some sepals on each fruit that are level, hard to hull, achenes are sunken; flesh: 60-80% light red, medium firmness; flavour: fairly good, bland, average acidity, not enough sugar. Plant: moderately vigorous, good runner production, fairly upright habit, productive; flowering: inflorescences are beneath to level with the foliage, fruiting trusses are long and semi-erect at first harvest. Diseases: moderately susceptible to leaf spot.

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Performance locale
Fruit : fruit cadet petit-moyen à moyen, parfois gros, cunéiforme-court à conique-globuleux, rouge pâle à rouge, moyennement luisant, à zone sans akènes étroite à moyenne, à calice généralement réfléchi et difficile à enlever ayant toujours un certain nombre de sépales plats, à akènes enfoncés; chair : 60-80% rouge pâle, moyennement ferme; saveur : assez bonne, fade, moyennement acide, insuffisamment sucrée. Plante : moyennement vigoureuse, à bonne production de stolons, à port assez dressé, productive; floraison : inflorescences portées plus bas que le feuillage ou au même niveau, grappes longues, demi-dressées à la première cueillette. Maladies : fraisier moyennement sensible à la tache commune.
EROS
EROS


LATESTAR

Origin: G.J. Galletta, J.L. Maas, J.M. Enns, USDA, Beltsville, Maryland. Introduced in 1995. Lateglow x Allstar. Fruit: attractive, large, vary in shape from broad-shouldered and blunt-tipped wedge for primary and secondary fruit to short conic for later fruit, bright glossy scarlet that changes to dark red in very ripe fruit, tough skin, calyx segments are clasping, achenes are yellow and recessed; flesh: uniform medium red, firm, juicy; flavour: pleasant, mildly aromatic, slightly acidic; end use: good fresh for local markets and for shipping; ripening: late, slightly after Allstar, Lateglow and Jewel. Plant: high vigor and yield, good runner production; flowering: slightly after Allstar, Lateglow and Jewel. Diseases: resistant to most of the common leaf diseases and fruit rots that occur in Maryland but susceptible to leaf blight, resistant to five races of red stele. Other: tested as MDUS 5084, produces well on either light or heavy soils, in matted-row or in raised-bed culture, planted in spring or summer.

Local performance
Fruit: primary fruit are large to very large and wedge shaped, secondary fruit are medium size to medium-large, conic to long-conic, dark red, glossy, band without achenes is very narrow to narrow, calyx segments are mainly clasping but can be level, hard to hull, achenes are sunken; flesh: 95% medium red, fairly firm; flavour: pleasant, aromatic, average sugar, medium-weak acidity. Plant: moderately vigorous, average number of runners produced, globose habit. Diseases: moderately susceptible to leaf spot.

Origine : G.J. Galletta, J.L. Maas, J.M. Enns, USDA, Beltsville, Maryland. Mis en circulation en 1995. Lateglow x Allstar. Fruit : attrayant, gros, à forme variant de “large d’épaules” et cunéiforme obtus (ainé et cadet) à conique court (fruits produits par la suite), luissant, écarlate vif devenant rouge foncé lorsque le fruit est très mûr, à peau très résistante, à calice embrassant, à akènes jaunes et enfoncés; chair : rouge moyen uniforme, ferme, juteuse; saveur : agréable, légèrement aromatique, légèrement acide; utilisation : fraise bonne pour les marchés de fruits frais locaux et pour le transport; maturation : tardive, un peu après Allstar, Lateglow et Jewel. Plante : très vigoureuse, à rendement élevé, à bonne production de stolons; floraison : un peu après Allstar, Lateglow et Jewel. Maladies : fraisier résistant à la plupart des maladies foliaires et des pourritures du fruit qui sont communes au Maryland, sensible à la brûlure des feuilles, résistant à cinq races de stèle rouge. Autres caractéristiques : fraisier mis à l’essai sous la désignation MDUS 5084, donnant une bonne production en sol léger et en sol lourd, en rangs nattés ou en planches surélevées, se plantant au printemps ou en été.

Performance locale
Fruit : fruit aîné gros à très gros et cunéiforme, fruit cadet moyen à moyen-gros, conique à conique-allongé, rouge foncé, luissant, à zone sans akènes très étroite à étroite, à calice généralement embrassant, mais parfois plat, difficile à enlever, à akènes enfoncés; chair : 95% rouge moyen, assez ferme; saveur : agréable, aromatique, moyennement sucrée, à acidité faible-moyenne. Plante : moyennement vigoureuse, produisant un nombre moyen de stolons, à port globuleux. Maladies : fraisier moyennement sensible à la tache commune.
TORO

Origin: R.S. Bringhurst, V. Voth, University of California, Davis, California. Introduced in 1975. Cal 37.20-45 x Sequoia. Fruit: medium-large, conic, pointed, bright orange-red; flesh: light red, moderately firm; flavour: sweet, acid; end use: resistant to travel, fair for desserts; ripening: early. Plant: vigorous, upright, does not produce many runners. Diseases: very susceptible to anthracnose, susceptible to red stele, verticillium wilt, leaf spot, leaf blight, powdery mildew, botrytis fruit rot, root-knot nematodes and mites, virus tolerant.

Local performance

Fruit: secondary fruit are medium size to medium-large, conic, orange-red, moderately glossy, band without achenes is narrow, calyx segments are level to reflexed, easy to medium to hull, achenes are level with the surface; flesh: 90% light red, medium firmness; flavour: not very pleasant, a bit bland, less than medium sweet, medium-strong acidity. Plant: weak grower, good runner production, flat-globose habit; flowering: inflorescences are beneath the foliage, fruiting trusses are medium length and semi-erect at first harvest. Diseases: plant is not very healthy in general, moderately susceptible to leaf spot and leaf scorch.


Performance locale

Fruit : fruit cadet moyen à moyen-gros, conique, rouge-orange, moyennement luisant, à zone sans achenes étroite, à calice plat à réfléchi facile à moyennement facile à enlever, à achenes affleurants; chair : 90% rouge pâle, moyennement ferme; saveur : pas très agréable, un peu fade, moins que moyennement sucrée, à acidité moyenne-forte. Plante : peu vigoureuse, à bonne production de stolons, à port globuleux-aplati; floraison : inflorescences portées plus bas que le feuillage, grappes de longueur moyenne, demi-dressées à la première cueillette. Maladies : fraisier pas très sain en général, moyennement sensible à la tache commune et à la tache pourpre.
VALENTINE
VALENTINE


Local performance
Fruit: primary fruit are short wedge, secondary fruit are medium size, conic, red which is darker on one side, fairly glossy, band without achenes is medium, calyx segments are mainly level, easy to medium to hull, achenes are level with the surface; flesh: 100% medium red, firm; flavour: fairly good, medium sweetness and acidity, lacks aroma, is a bit tastier when overripe. Plant: vigorous, good runner production, flat-globose habit; flowering: inflorescences are beneath to level with the foliage, fruiting trusses are medium length and almost prostrate at first harvest. Diseases: moderately susceptible to leaf scorch.


Performance locale
Fruit : fruit aîné cunéiforme court, fruit cadet de moyenne grosseur, conique, rouge avec un côté plus foncé que l’autre, assez luisant, à zone sans akènes de largeur moyenne, à calice généralement plat facile à moyennement facile à enlever, à akènes affleurants; chair : 100% rouge moyen, ferme; saveur : assez bonne, moyennement sucrée, moyennement acide, manquant d’arôme, ayant un peu plus de goût lorsque le fruit est avancé. Plante : vigoureuse, à bonne production de stolons, à port globuleux-aplati; floraison : inflorescences portées plus bas que le feuillage ou au même niveau, grappes de longueur moyenne, presque étalées à la première cueillette. Maladies : fraisier moyennement sensible à la tache pourpre.
3.2. Day-neutral or everbearing

3.2. Fraisiers à jour neutre ou remontants
Origin: D.V. Shaw, University of California, Davis, California. Introduced in 1999. Cal 87.112-6 x Cal 88.270-1. Fruit: large to very large, conical, there are marked differences between the shapes of the primary and secondary fruit, very narrow band without achenes, dark red skin that is even to slightly uneven in color, very glossy, calyx is larger than the size of the fruit diameter and is set level with the surface, calyx segments are reflexed, hard to hull, achenes are inserted level with the fruit surface; flesh: uneven light red, extremely firm, coarse texture; flavour: weak sweetness, weak acidity; end use: fresh markets, processing, home gardens; ripening: day-neutral, starts producing slightly later and produces substantially larger quantities of late season fruit compared to Selva or Seascape. Plant: medium to high tolerance to low temperatures, medium to strong vigor, globose habit, medium to dense, few stolons are produced, leaves are medium green in color with a slightly convex profile and medium to strong blistering; flowering: inflorescences are beneath to level with the foliage, flowers are medium in size and the petals are overlapping with a length/width ratio that is broader than long, fruiting trusses are erect and short. Diseases: moderately susceptible to common leaf spot and verticillium wilt, relatively resistant to powdery mildew and anthracnose crown rot, more tolerant to two-spotted spider mites than Seascape and Selva, tolerant to strawberry viruses in California. Other: tested as Cal 91.248-3 and CN209.

**Local performance**

Fruit: secondary fruit are large, conic or wedge, red, glossy, band without achenes is very narrow, calyx segments are clasping to level, hard to hull, achenes are sunken; flesh: firm; flavour: bland, not sweet, weak acidity. Plant: moderately vigorous, medium density, less than average number of stolons produced, flat-globose habit; flowering: inflorescences are medium size to medium-long and are semi-erect at first harvest. Diseases: moderately susceptible to leaf scorch and leaf spot.

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Origine : D.V. Shaw, University of California, Davis, Californie. Mis en circulation en 1999. Cal 87.112-6 x Cal 88.270-1. Fruit : gros à très gros, conique, avec des différences de forme très marquées entre le fruit aîné et le fruit cadet, à zone sans akènes très étroite, à peau rouge foncé de couleur unie à légèrement inégale, très luisant, à calice de diamètre supérieur à celui du fruit, inséré sur une surface plane, réfléchi, difficile à enlever, à akènes affleurants; chair : rouge pâle inégal, extrêmement ferme, à texture grossière; saveur : légèrement sucrée, à faible acidité; utilisation : marchés de fruits frais, transformation, jardin familial; maturation : fraisier à jour neutre, commençant à produire un peu plus tard que Selva et Seascape et produisant beaucoup plus en période de fructification avancée que ces deux cultivars. Plante : possède une tolérance moyenne à élevée aux basses températures, moyennement à très vigoureuse, à port globuleux, moyennement dense à dense, produisant peu de stolons, à feuilles vert moyen un peu convexes en coupe transversale et moyennement à fortement cloquées; floraison : portées plus bas que le feuillage ou au même niveau, fleurs de grandeur moyenne, pétales chevauchants et plus larges que longs, grappes dressées et courtes. Maladies : fraisier moyennement sensible à la tache commune et au flétrissement verticillien, relativement résistant au blanc et à l’anthracnose du collet, plus tolérant que Seascape et Selva au tétranyque à deux points, tolérant aux virus du fraisier présents en Californie. Autres caractéristiques : fraisier mis à l’essai sous les désignations Cal 91.248-3 et CN209.

**Performance locale**

Fruit : fruit cadet gros, conique ou cunéiforme, rouge, luisant, à zone sans akènes très étroite, à calice embrassant à plat difficile à enlever, à akènes enfoncés; chair : ferme; saveur : fade, non sucrée, à faible acidité. Plante : moyennement vigoureuse, moyennement dense, produisant moins que le nombre moyen de stolons, à port globuleux-aplati; floraison : inflorescences portées plus bas que le feuillage à un peu plus haut, grappes moyennes à moyennes-longues, demi-dressées à la première cueillette. Maladies : fraisier moyennement sensible à la tache pourpre et à la tache commune.
TRISTAR
TRISTAR


Local performance
Fruit: secondary fruit are globose-conic, red to dark red, not so glossy, band without achenes is broad, calyx segments are reflexed, fairly easy to hull, achenes are level with the surface; flesh: medium to dark red, firm; flavour: very good, high acidity, medium to high sugar. Plant: good runner production, medium green foliage; flowering: inflorescences are beneath the foliage, flowers are small to medium size. Diseases: moderately resistant to leaf spot.

D’après la littérature
Origine : D.H. Scott, A.D. Draper, G. Galetta, H. Swartz, USDA, Beltsville, Maryland. Mis en circulation en 1981. EB 18 (MDUS 3082 x Cal 65.65-601) x MDUS 4258 (MDUS 2713 x MDUS 3364). Fruit : moyen à petit, rouge, luisant; Chair : ferme; Saveur : bonne, sucrée et aromatique; Utilisation : consommation en frais; supporte mal le transport; Maturation : variété remontante. Maladies : fraisier résistant à la stèle rouge et au blanc, modérément résistant à la flétrissure verticillienne et à la tache pourpre.

Performance locale
Fruit : fruits secondaires globuleux à coniques, rouges à rouge foncé, pas très luisants; bande sans akènes large; segments du calice réfléchis; assez facile à équeuter; akènes affleurants; Chair : rouge intermédiaire à rouge foncé, ferme; Saveur : très bonne, très acide, moyennement sucrée à très sucrée. Plante : bonne production de stolons, feuillage vert intermédiaire; Floraison : inflorescences situées sous le feuillage; fleurs petites à moyennes. Maladies : fraisier modérément résistant à la tache commune.
3.3. Ornamental

3.3. Fraisiers décoratifs
FRAGARIA VESCA ‘VARIEGATA’
FRAGARIA VESCA ‘VARIEGATA’

Needs well drained, moist soil, occasional leaf burn when exposed to full sun shine, leaves are variegated and small, most of the flowers are aborted and occasionally produce very small berries that never reach maturity, good for home gardener, ornamental, ground cover, not very hardy.

Le fraisier à besoin d’un sol bien drainé et humide, brûlure occasionnelle des feuilles une fois exposé au plein soleil, les feuilles sont panachés et petites, la plupart des fleurs sont abandonnés et produisent de temps en temps de très petits fruits qui n’atteignent jamais la maturité, fraisier bon pour le jardin familial, ornamental, couvre-sol, non rustique.
ROSEBERRY
ROSEBERRY

Origin: S. Khanizadeh, M. Deschênes, A. Levasseur, Agriculture and Agri-Food Canada, St-Jean-sur-Richelieu, QC. Fern x (SJ9616-1 x Pink Panda). Introduced in 2004. Fruit: large, primary fruit are kidney or wedge shape, secondary fruit are very small to medium size, globose, red, moderately glossy, band without achenes is medium, calyx segments are clasping, calyx has medium adherence to fruit, achenes are level with the surface; flesh: 80% medium red, fairly firm; flavour: aromatic, medium sweet, medium-strong acidity; end use: ornamental; ripening: day-neutral. Plant: vigorous, flat habit; flowering: flowers have a bright pink center (RHS 57A) surrounded by a lighter pink area (RHS 62A) on the surface, diameter of calyx is smaller relative to corolla, petals are overlapping and broader than long, inflorescences are level with to above the foliage, fruiting trusses are long and erect at first harvest. Diseases: moderately susceptible to leaf spot, resistant to leaf scorch. Other: tested as SJO9625-86, winter hardy.

Origine : S. Khanizadeh, J. Cousineau, M. Deschênes, A. Levasseur, Agriculture et Agroalimentaire Canada, St-Jean-sur-Richelieu, Québec. Fern x (SJ9616-1 x Pink Panda). Fruit : gros, fruit aîné réniforme ou cunéiforme, fruit cadet très petit à moyen, globuleux, rouge, moyennement luisant, à zone sans akènes de largeur moyenne, à calice embrassant moyennement facile à enlever, à akènes affleurants; chair : 80% rouge moyen, assez ferme; saveur : aromatique, moyennement sucrée, àacidité moyenne-forte; utilisation : ornement; maturation : fraisier à jour neutre. Plante : vigoureuse, à port aplati; floraison : inflorescences portées au niveau du feuillage ou plus haut, à fleurs à dessus rose vif (RHS 57A) au centre et d'un rose plus pâle (RHS 62A) en bordure, dont le calice est d'un diamètre inférieur à celui de la corolle et dont les pétales sont chevauchants et plus larges que longs, avec des grappes longues, dressées à la première cueillette. Maladies : fraisier moyennement sensible à la tache commune, résistant à la tache pourpre. Autres caractéristiques : fraisier mis à l'essai sous la désignation SJO9625-86, rustique.
3.4. Other species

3.4. Autres espèces
FRAGARIA VESCA ‘YELLOW WONDER’ (ALPINE STRAWBERRY)
FRAGARIA VESCA ‘YELLOW WONDER’ (ALPINE STRAWBERRY)

Fruit: small, yellow-white; flavour: sweet; end use: good for decorating dishes and drinks. Other: prefer soil with good drainage and moisture.

Detailed descriptions of plant, leaf, flower and fruit characteristics of strawberry varieties are not only important for plant breeders but can also be used as a tool to identify varieties. This information is required by the Plant Breeder’s Rights Office (PBRO) when an application is submitted for examination of a candidate variety vs. the reference variety.

In the last several years, efforts were put together to set up a complete agronomical and morphological description of strawberry varieties (UPOV, 1995; Faedi et al., 1988; http://www.ars-grin.gov/cgi-bin/npgs/html/desclist.pl?78). Dale (1996) reported a key and vegetative descriptions of 32 common strawberry varieties grown in North America. Khanizadeh and Ghavami (2004) developed a user-friendly software that allows the user to create their own instant database and image inventory by importing existing data and images for over 1000 genotypes (www.unibase.ca).

In the last 10 years, several selections were released from the National Strawberry Breeding program of Agriculture and Agri-Food Canada (AAFC), and in all cases a selection of one or more reference varieties was mandatory when describing a new variety. During the course of the selection and cultivar evaluation, information was also collected on other selections that were thought to have a potential in the breeding program. This document includes a list of over 100 strawberry cultivars that were evaluated during 1997-2003. The objective was to document the field performance of these cultivars by evaluating their capacity to withstand cold temperatures and disease resistance as well as describing other important characteristics, some of which directly or indirectly affect fruit quality, productivity or shown to have a relation with pre-and postharvest fruit diseases (Olcoot-Reid and Moore, 1995), such as vigor, firmness, flesh color, sugar, acidity and texture. These data, along with that collected from advanced selections, or a source of information used to select parentages in order to develop new lines. This information is also available in an electronic format via UniBase (http://www.unibase.ca).

The data presented in this section is the overall average of observations taken during the past 7 years. Plants were established at the AAFC Sub-Station located in L’Acadie, Qc, where the data were collected from 10 typical plants during the second growing season (1st harvest season). The information contained in this chapter was collected according to the guidelines and procedures recommended by the Canadian ‘Plant Breeders Rights Office’ (http://www.inspection.gc.ca/english/plaveg/pbrpov/guidee.shtml).

The rating system used in this report is a scale ranging from either 1 to 9 or 3 to 7. Sometimes the symbol “ - ” or a dash can be found between two numbers and this indicates that the observation is within a certain range but intermediate values that grade gradually from one extreme to another can also be used even though they are not in the legend. For example, where it states for characteristic are described as 3 to 7 and it represents small (3), medium (5), large (7); other values such as 1, 2, 4, 6, 8 or 9 may also be used (Agriculture and Agri-Food Canada, 1993). Contrary to the above, the comma “ , ” indicates the possibility of a certain description but not any other values range. For example, cultivars rated 4, 5, 7 for fruit shape, represent only three distinct shapes (e.g. conic, bi-conic and wedged) and nothing between the values.

Plant characteristics such as habit, density and vigor were observed on 1-year-old plants a few days after the beginning of fruit ripening (Table 1). A diagram (chapter 11) was used to classify the varieties based on their growing habit. Vigor was rated according to the quantity and quality of the foliage (before the appearance of foliar disease) on an individual plant basis, whereas density was rated by the number of plants per square meter. Stolon characteristics, including number, thickness, pubescence and anthocyanin coloration, were recorded in the fall on 1-year-old plants (Table 1). Cultivars were tested shortly after the last harvest for their field susceptibility to leaf spot and leaf scorch. To evaluate the degree of susceptibility, a visual assessment of both diseases based on the density of spots per foliage and the number of plants infected per plot was used as well as a few reference varieties. For example: ‘Kent’ scored 9 (highly susceptible) for leaf spot, which means it had spots on the 10 typical plants and there were several spots per plant. It is important to note that the reaction to leaf diseases might not be the same in other regions due to the interaction between the cultivars, the growing condition and regional climate.

Leaf characteristics, including the color of upper side, blistering, number of leaflets and characteristics of the terminal leaflet such as length/width ratio (see diagram, chapter 11), shape of base (see diagram, chapter 11) and shape of teeth (see diagram, chapter 11), as well as petiole characteristics, including pubescence and pose of hairs, were evaluated during the second growing season (Table 2). Shortly after harvest, 10 mature leaves were selected randomly from 10 typical plants. These characteristics were measured in the first and second growing years and looked to be very consistent from year to year.

Flower, inflorescence and fruiting truss characteristics, including position of the inflorescence relative to the foliage, flower size, diameter of inner calyx relative to outer (see diagram, chapter 11), diameter of the calyx relative to corolla, petal spacing (see
## Table 1. Plant characteristics, stolon characteristics and reaction to diseases.

<table>
<thead>
<tr>
<th>CULTIVAR</th>
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<th>Stolon Characteristics</th>
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Legend:

**Plant Characteristics:**
- Habit: 1=upright, 2=globose, 3=flat-globose, 4=flat
- Density: 3=open, 5=medium, 7=dense
- Vigor: 1=very weak, 3=weak, 5=medium, 7=strong, 9=very strong

**Stolon characteristics:**
- Number: 3=few, 5=medium, 7=many
- Anthocyanin coloration: 1=absent or very weak, 3=weak, 5=medium, 7=strong, 9=very strong
- Thickness: 1=very thin, 3=thin, 5=medium, 7=thick, 9=very thick
- Pubescence: 1=absent or very sparse, 3=sparse, 5=medium, 7=dense, 9=very dense

**Reaction to Diseases:**
- Blank not evaluated, 1=resistant, 3=fairly resistant, 5=moderately susceptible, 7=susceptible, 9=highly susceptible
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<th>Length/width</th>
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<th>Shape</th>
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**Legend:**

**Fruit characteristics (observed on secondary fruits):**

- Ratio of length / maximum width: 1=much broader than long, 3=broader than long, 5=as long as broad, 7=longer than broad, 9=much longer than broad
- Size: 1=very small, 3=small, 5=medium, 7=large, 9=very large
- Shape: 1=kidney shape, 2=oblate, 3=globose (round), 4=conic, 5=bi-conic, 6=almost cylindrical, 7=wedged, 8=ovoid, 9=cordate, 10=globose-conic (round-conic)
- Difference in shape between primary and secondary fruits: 1=none or very slight, 3=slight, 5=moderate, 7=marked, 9=very marked
- Band without achenes: 1=absent or very narrow, 3=narrow, 5=medium, 7=broad, 9=very broad
- Unevenness of surface: 1=absent or very weak (smooth), 2=weak, 3=medium, 4=strong, 5=very strong (rough)
- Skin color: 1=whitish yellow, 2=light orange, 3=orange, 4=orange-red, 5=red, 6=dark red, 7=dark purple, 8=light red
- Evenness of color: 3=uneven, 5=slightly uneven, 7=even
- Glossiness: 3=weak, 5=medium, 7=strong
- Insertion of achenes: 3=below surface, 5=level with surface, 7=above surface
- Insertion of calyx: 3=in a basin, 5=level, 7=set above fruit
- Pose of calyx segments: 1=clasping, 1.5=level, 2=reflexed
- Size of calyx in relation to fruit diameter: 3=smaller, 5=same size, 7=larger
- Adherence of calyx: 3=weak, 5=medium, 7=strong
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Shahrokh Khanizadeh was born in Kerman, Iran and moved to Tehran in 1965. After finishing high school at Firooz Bahram in 1971, he enrolled at Tehran University and obtained a degree in agricultural engineering in 1975. In 1979, he moved to Montreal and graduated in 1983 with a M. Sc. in small fruit culture and physiology from McGill University. During his studies he taught plant physiology, pomology and statistics courses at McGill University. In 1989, he earned a Ph. D. in tree fruit physiology from McGill and joined the Plant Science Department as a Research Associate. He acted as a statistical consultant for Agriculture and Agri-Food Canada (AACF) during 1990-92 while completing his post-Doctoral research in plant breeding. In 1992, he became an Assistant Professor at McGill University and also started working part-time for AACF as a plant breeder and physiologist. Three years later, he accepted a full-time Research Scientist position at AACF. Since 1992, he has released 11 new June bearing strawberry cultivars and two day neutral red flowering cultivars ‘Rosalyne’ and ‘Roseberry’ for home gardeners. He also was involved in the release and naming of five hardy scab resistant apple cultivars ‘Belmac’, ‘Primevère’, ‘Galarina’, ‘Reinette Russet’ and ‘SuperMac’, one winter hardy scab resistant columnar habit growing apple ‘MacExcel’ for home gardeners and four winter hardy dwarf apple rootstocks ‘SJM15’, ‘SJM167’, ‘SJP84-5198’ and ‘SJP84-5218’. 

http://res2.agr.gc.ca/stjean/personnel/khanizadeh_e.htm & www.pgris.com


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